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Hayward Shoreline Environmental Analysis

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Hayward Shoreline Environmental Analysis

PREPARED FOR THE

HAYWARD AREA SHORELINE PLANNING AGENCY

by

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HAYWARD AREA SHORELINE PLANNING AGENCY

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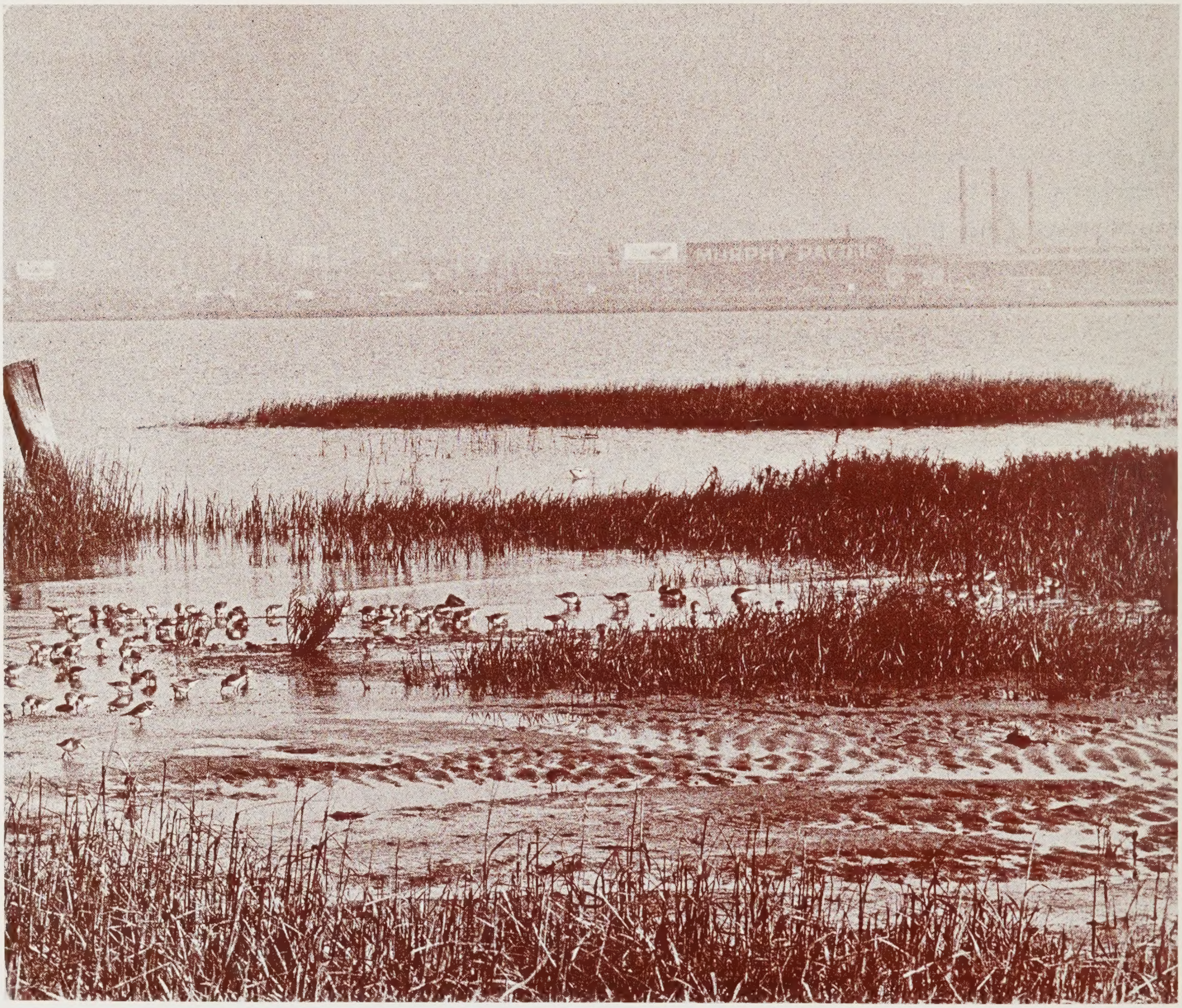
TYPICAL SHORELINE SCENE-- SAN FRANCISCO BAY



Introduction

Summary of Findings

The Hayward Shoreline area was formerly almost entirely within the historic tidal zone of San Francisco bay. Diking of the tidal lands was established to create land for grazing, and for salt production.

The existing levee system affords protection against salt water and fresh water flooding but also requires constant maintenance. Removal of the levees would restore most of the area to its former tidal marsh condition.

The area above the old tidal zone is suitable for development as residential and industrial, and considerable industrial development has taken place already.

A narrow strip of old tidal marsh which borders the uplands is suitable for development as residential or industrial with the exercise of proper engineering controls.

The most significant environmental factors regarding the use of the planning area relate to the geologic and ecologic conditions. About 4/5 of the area is underlain by thick sections of soft, unstable "bay muds" and liquefable lenses that create engineering problems. This portion of the study area is best suited for open space, salt production, development as recreation, or left in a natural state. Much of this open space area is still in the form of ponds used for the production of salt.

The salt ponds have a strong environmental effect on the ecology providing feeding and roosting habitats for migratory birds and as a favorable contribution to the climatic conditions.

Soils in the area, while favorable to the production of salt because of their impermeability, are unfavorable for certain sewage disposal procedures because of their drainage characteristics, high water table and high corrosivity. Pumping plants to remove surface waters encounter difficulties in areas of high water tables since ground water may be pumped out inadvertently.

Because of the low elevation in the lands in the old tidal zone, pumping plants are required to remove the raw sewage.

The most valuable ecological habitat is the salt marsh at the mouth of the Alameda Flood Control channel and should remain in its present natural state.

Any existing salt marsh should be retained because of the dependence of several rare spacies (Clapper Rail and Salt Marsh Harvest Mouse) and because of the extremely high productivity of this biological system.

Some low salinity salt ponds adjacent to the salt marsh should be encouraged to revert to this habitat form.

Any increase in the acreage of fresh water ponds would be highly beneficial to wildlife.

Any development on filled lands underlain by thick sections of bay mud would sustain damage in a major earthquake due to differential settlements or ground lurching from strong ground motions. The most serious damage and most costly to the taxpayers would be the rupture of all the underground utility lines such as water, gas, and sewer.

The large acreage of water in the salt ponds exerts a positive influence on the climatic conditions that relate to temperature, wind, and ultimately air pollution.

The construction of facilities such as jetties, piers, outfalls, marinas, and islands can have a significant effect on the hydraulics of the shoreline area.

Minor changes can be expected in the microclimate of the shoreline and Hayward City area if there is any change in the present land use.

The Planning Program

The Hayward Area Shoreline Planning Agency (HASPA) composed of the East Bay Regional Park District, Alameda County, Hayward Area Recreation and Park District and the City of Hayward was established in 1971 for the purpose of preparing policies and a plan for the Hayward Area Shoreline, a 31 square mile land and water area between San Leandro and Fremont in Alameda County.

Assisting in the program area the staff members of the four agencies and the San Francisco Bay Conservation and Development Commission (BCDC) who form the Hayward Area Shoreline Technical Advisory Committee (HASTAC). This committee prepared a series of comprehensive background reports and maps dealing with the physical and biological environment of the Hayward Area Shoreline.

Scope and Purpose of The Study

This study was conducted to prepare a summary (environmental synthesis) and analyses of the physical and biological environment to provide staff with a working document which can aid the planner in *land use decisions.* Of prime concern is the identification of beneficial or detrimental effects of planning decisions, through the identification of the environmental elements which must be preserved or enhanced to provide for a desirable balanced ecological system on the shoreline, and also those environmental elements which provide opportunities for meeting human needs.

The study was conducted over a six month period, under contract to the Agency. It was anticipated that the technical background reports prepared by various governmental agencies on the physical environment would contain sufficient data on which to base an environmental analysis and that no new data would be developed. However, although most of the physical elements were covered such as tides and currents, soils, hydrology and climate, sufficient data were lacking on geologic and ecological factors.

Consequently, additional field and interpretive work pursuant to an ecologic analysis was prepared by John Werminski, biologist, and additional data prepared by the author on engineering geology and seismicity.

Consultations were held with members of the engineering and geologic professions to determine the relationship of the local geology to construction under current engineering practice. The study was reviewed with Mr. William Spangle, Consulting Planner with reference to the planning implications of the technical data.

Acknowledgements

In a large part, this analysis is based upon a synthesis of the following background reports:

Tides and Currents in South San Francisco Bay as they affect the Hayward Shoreline Plan by L. Thomas Tobin, San Francisco Bay Conservation and Development Commission, May 1973.

Weather and Climate Element of Hayward Area Shoreline Study by the Hayward Planning Department, Sept., 1971.

Hydrology by Leon Schactmeyer, Alameda County Flood Control and Water Conservation District, June 1972.

The Hayward Shoreline – An ecological report with recommendations by H.T. Harvey and J.P. Heath, San Jose State.

Other background material in chart and map form include:

Soils of the Hayward Shoreline Area by Clifford Landers and Denis Nickel, U.S. Dept. of Agriculture, Soil Conservation Service.

Some Factors Affecting Foundation Conditions in Areas of Former Marshlands, Hayward and Vicinity, Calif. and Location of Granular Layers and Data Points for Marshland Area, Hayward and Vicinity, Calif. by S.D. McDonald and D.R. Nichols, U.S. Geological Survey, Menlo Park, Calif.

Of invaluable aid was the comprehensive (unpublished) work done by Dr. Howard L. Cogswell on the wildlife in the area. Dr. Tom Harvey's recommendations were particularly useful to the ecological analysis. The Leslie Salt Co. was particularly helpful in providing access to their properties in the area. The technical background reports listed above are available on loan bases, through City of Hayward Planning Department. Other selected references pertinent to the study are listed in the bibliography.

Characteristics of the Area

The shoreline area included in this study is generally described as the 31 square mile land and water area from the southern San Leandro City limits at the north, to the Southern Pacific tracks on the east, the City of Hayward City limits on the south, and the County boundary on the west.

The area consists of essentially flat, featureless, low-lying lands in the former historic tidal zone and adjacent bay plain. Fine-grained, silty clay soils overlie the major portion of the area. The western portion is underlain by increasing thicknesses of soft compressible silts and clays – the so-called "bay mud." All the area is underlain by hundreds of feet of unconsolidated sands, silts and clays over a deep Franciscan Formation "bedrock."

Most of the study area was diked in the past to create agricultural land and for the production of salt. Presently, about 6,000 acres of salt ponds are still used for the production of salt by solar evaporation. The remainder of the land is cultivated (2300 acres), and in light industrial development. Sanitary land fill operations are active north of the San Mateo Bridge near Hayward Landing.

Vegetation, wildlife and bird population abound in the tidal zone and salt ponds.

Organization

The study is divided into two sections. The first, the environmental analysis, defines the general environmental units which have their bases in an ecologic, geologic, meterologic, hydrologic, biologic, or other physical concept. These units are defined and represented on maps showing their areal distribution. The factors for the continued existence of each unit are defined and their implication for planning discussed.

The second section, the Land Use Synthesis, consists of a summary map and analyses of the study area and categorization of the type of land uses that can be supported. Three types of areas are designated: Areas capable of development, areas to remain as open space or developable for recreation, and areas recommended to remain in or revert to a natural state.

VIEW OF NORTHERN PORTION OF HAYWARD SHORELINE AREA

Geology

Introduction

Geologic conditions in the shoreline area are among the most significant aspects of the entire study in terms of land use allocation due to the identification of areas unsuitable for development.

The bulk of the shoreline area is underlain by soft, compressible, fine-grained sediments that are undesirable to build upon because of engineering problems such as differential settlement and the potential for damage to structures from intense shaking during an earthquake on the nearby active Hayward Fault.

Methodology and Level of Accuracy

The geologic information for this study was prepared by the U.S. Geological Survey as an integral part of their study of the San Francisco Bay Region. The City of Hayward assisted in the collection of drill logs analyzed by the Survey. For this study, the U.S. Geological Survey prepared two maps on which the significant subsurface geologic units were delineated, including sand lenses subject to liquefaction, and thicknesses of the younger bay mud, and depths to bedrock.

The accuracy of the location of the contour lines representing the thickness of bay mud depends upon the number and location of the drill holes. In the salt pond area, there are few wells and the contour lines there are approximately located. The depths of bedrock were determined by the U.S. Geological Survey using refraction seismic geophysical methods.

Units

The rocks in the study area fall into the three age groups: The deeply buried Franciscan Formation "bedrock"; an overlying younger sequence of interbedded sediments — sand, silt, and clay; and the younger silty clay unit termed the younger "bay mud."

BEDROCK

The bedrock underlying most of San Francisco Bay is composed of sandstone, siltstone, chert, and greenstone of the Franciscan Formation. The bedrock crops out on the margins and surface of the bay and is encountered in drill holes.

The bedrock drops off sharply on the margin of the west side of the bay and deepens to the east. In the Hayward Shoreline area, the depth to bedrock varies from less than a thousand feet south of the San Mateo Bridge to depths greater than 1300 feet between the San Mateo Bridge and San Leandro. These depths were determined by the U.S. Geological Survey using refraction geophysical methods. The difference in bedrock depths may be due to deep stream erosion prior to deposition of overlying sediments, warping or faulting.

The engineering problems of the bedrock relate primarily to the strength of the rock for foundation purposes and the slope of the bedrock surface. In the shoreline area, the bedrock is so deep as to be of no significance for foundation consideration.

OLDER BAY SEDIMENTARY SEQUENCE

During the formation of the present bay, alluvial and estuarine sediments accumulated in the San Francisco bay depression. The upper 300 feet are known from borings to consist of varying thicknesses of silt, clay, sand and gravel. Presumably the sequence of sediments extends to the bedrock in the shoreline area.

The distribution of the older bay alluvial sediments in the study area is shown on Plate I. This unit, where free from soft clays, presents no unusual foundation or stability problems.

YOUNGER BAY MUD

Younger bay mud is the youngest geologic unit in San Francisco Bay overlying the older sediments and covering most of the bay bottom. The unit, which consists of a soft, gray, silty clay containing 45% to

95% clay size particles, silt, minor fine sand and fragments of shells, tends to become firmer and contains less water with increasing depth.

The clay contains mica, montmorillonite, chlorite, kaolinite, quartz, and feldspar. The clay is soft and plastic when wet and tends to shrink, harden and become brittle upon drying.

The younger bay mud was deposited upon an erosional surface cut to depths of as much as 200 feet below sea level and attains thicknesses of as much as 130 feet. The bay mud in the shoreline area increases in thickness toward the bay and attains a thickness of at least 35 feet at the west edge of the area.

Radiocarbon dating from samples in the younger bay mud have yielded ages ranging from 2,420 years to 7,360 years old.

EARTHQUAKE DAMAGE CAUSED BY GROUND FAILURE DUE TO LIQUEFACTION, NIIGATA, JAPAN, 1964

SEISMICITY

The Hayward Shoreline Area is located in a region that has experienced frequent earthquakes, some of which have been strong and destructive. The area lies near the Hayward Fault, which is one of the most active faults in the United States. The Hayward hills owe their elevated topography to movements along this fault, which trends northwesterly along the westerly front of the hills from San Jose to San Pablo. The most recently active portion is the 50-mile stretch from Milpitas to San Pablo.

The Hayward Fault has been known to have moved both vertically and horizontally during faulting. At present, there is evidence of tectonic creep along the fault in the City of Hayward where curbs are being offset at an average rate of 0.17 inches per year.

Historically, the Hayward area has had substantial seismic activity. Between 1836 and 1958, 25 shocks originated on the Hayward Fault or branches of it. These earthquakes ranged from mild local tremors to severe shocks in 1836 and 1868 of intensity X. The 1868 earthquake severly damaged almost every building in Hayward and some were completely destroyed. Damage extended as far south as Santa Cruz and Gilroy and north to Santa Rosa. About 30 people lost their lives, chiefly due to falling bricks. Other less intense shakes caused falled chimneys, cracked walls, and broken water and sewer mains.

From 1962 through 1970, 72 earthquakes of magnitude 2.5 or greater occurred in an area bounded by Berkeley, Danville, and Hayward. Because of the greater number of quakes in this area, the U.S. Geological Survey has labeled it a "High Active Seismicity Area."

Estimates made by Tudor Engineering (1973) for the Santa Clara Flood Control District indicate that the recurrence probability of earthquakes of magnitude 5 is five to ten years; earthquakes of magnitude 5.5 is 10 to 20 years, while the maximum credible earthquake of magnitude 7.5 is 500 to 1,000 years along the Hayward fault.

ENGINEERING PROPERTIES OF THE YOUNGER BAY MUD

Foundation Problems

Geologists and engineers have long recognized that, from the soil mechanic and foundation engineering standpoints, the younger bay mud is the most troublesome of the sediments of the bay. The foundation problems arise from the nature of the bay mud, which is primarily a soft, silty clay. The clay has a high natural water content, is quite plastic and weak, and highly compressible. Because of its low strength, the mud cannot support structures placed directly upon it.

Engineered fills must be placed carefully upon the mud to provide sufficient support for even light structures.

Fills, embankments, and dikes require great care in construction. When younger bay mud is overloaded by fill, it becomes increasingly unstable as the height of the fill increases, and if the slopes on the edges of the fill are steep, will ultimately fail. During construction of the mole fill north of the Toll Plaza of the San Francisco-Oakland Bay Bridge in 1947, the mud was overloaded with a sand fill and failed. The sand sank 20 feet and the underlying mud was forced laterally for more than 500 feet.

The high water content, low strength, and high compressibility cause the mud to consolidate markedly under the weight of fills and structures, and settlement of the land surface occurs. Differential settlement results from variability in the thickness of the mud, or from a change in the composition within the mud.

At the mole fill mentioned above, settlements of more than eight feet took place during the first 20 years after construction. The settlement varied almost directly with the thickness of the underlying mud.

The mud is a poor formation for the support of friction piles, and it is necessary to carry building loads through the mud to firmer strata below. Engineers attempt to place piles in firm beds below the base of the mud. Even with this type of foundation support, there have been instances where the continued consolidation of the mud around the piles added loads to the piles that caused them to settle. Ordinarily, construction on a site that is underlain by five feet or less of bay mud does not present any particular soils engineering problems. Foundation treatment can consist of using short piles, surcharging, (overloading the mud to accelerate consolidation) or removal of the mud.

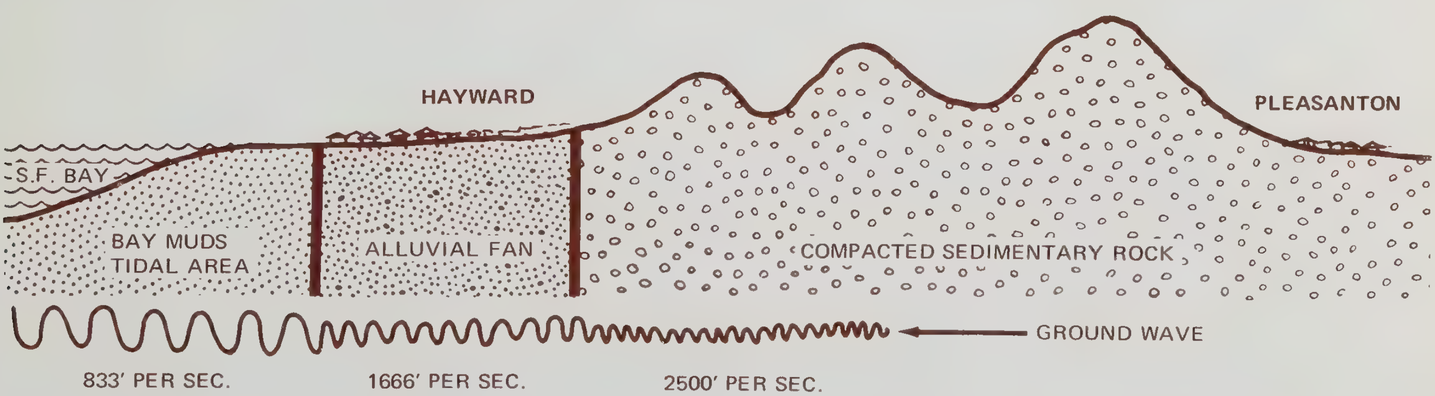
Sites underlain by greater thicknesses of bay mud become more difficult, expensive, and time consuming to treat, and are therefore subject to the difficulties and problems outlined previously.

Seismic Effects

The problem of seismic effects upon unconsolidated sediments has been known to geologists and engineers for some time. Because of the low strength and high water content, the effects of shaking during an earthquake are more pronounced on the soft muds than on more consolidated sediments or solid rock.

The expected damage that may result from a strong earthquake can take the form of settlement, liquefaction, lateral spreading, ground shaking, ground rupture, or tsunami.

- *Settlement.* – Ground shaking as the result of an earthquake can cause local settlement of the land surface if loose soils such as sand are present at shallow depths. The settlement occurs because of the rearrangement of the grains into a more dense form that occupies less space and allows the ground to settle. Those ground settlements due to compaction from earthquake vibration may lead to differential or non-uniform settlement, causing a structure upon it to tilt, warp, or crack.



The relative frequency, amplitude, and duration of ground waves increases as it passes from highly compacted material to less compacted material. Therefore, ground shaking will last longer and have a greater amplitude in the bay muds than in the hill's underlying sedimentary rock.

• *Liquefaction* — If loose or medium dense, saturated silts or sands are subjected to earthquake ground vibrations, water is caused to flow upward to the ground surface and will turn the sand into a "quick" or liquefied condition. Structures founded on such a liquefiable layer may settle differentially, or even rotate.

The variables affecting the liquefaction potential of a given layer of silt or sand are the grain size and the depth and location of the water table. In the Hayward Shoreline Area, shallow, loose sands and silt under the high water table conditions are most susceptible to liquefaction and, where known from borings, are shown on Plate I.

• *Lateral Spreading* — If liquefaction occurs in a earth mass that is gently sloping, the entire mass may slide laterally into an area at lower elevations.

The areas susceptible to lateral spreading are excavations, canals, ditches, shorelines, and ship channels. During the 1906 earthquake, much damage was caused by lateral spreading at the contact between the soft bay mud and stiffer soils.

Areas susceptible to lateral sliding in the shoreline area have been included with the areas subject tc liquefaction shown on Plate I.

• *Ground Shaking* — Ground shaking — the earthquake itself — consists of complex wave motion which has traveled through the rock materials. Earthquake waves may be reflected, refracted, and change velocity (speed) as they pass through different materials, thus making the ground motion complex.

In general, earthquake waves, in passing from more dense solid rock to less dense alluvial and water-saturated materials, tend to become reduced in velocity and increased in amplitude, and duration, and with longer periods of vibration. Ground motion thus lasts longer on loose, water-saturated, incompetent materials such as bay mud than on rock. Due to a combination of factors, most structures located on such material generally suffer far greater damage than those on solid rock.

The Earthquake Commission report on the San Francisco 1906 earthquake documented exaggerated shaking in the lower waterfront areas of San Francisco underlain by the thickest bay mud and fill, as compared to lesser shaking on Nob Hill and similar areas with more solid rock at or near the surface.

According to the U.S. Geological Survey, the natural period ranges from 0.2 seconds near the Coyote Hills, to about 3 seconds sound of the San Mateo Bridge, to greater than 4 seconds north of the San Mateo bridge.

Apparently, the deep deposits of alluvial sediments tend to amplify the long-period portion of the ground motion and thus create a potential for damage to tall structures that have long natural period of vibration.

In their study of the baylands in Santa Clara County, Tudor Engineering (1973) calculated that surface accelerations greater than 0.4G (0.4 times the acceleration of gravity which is 32.2 feet per second) could be generated during an earthquake on the Hayward or San Andreas Fault. The Hayward Shoreline area, with similar subsurface geologic characteristics and proximity to the Hayward Fault, also could experience this magnitude of ground motion.

In many earthquakes, "poor ground" is a greater hazard than proximity to the fault and epicenter. In 1906, Santa Rosa and San Jose, both underlain by thick alluvium, suffered extensive damage out of proportion to their distance from the movement on the San Andreas Fault.

Engineers have demonstrated that one of the critical factors contributing to earthquake damage is the relationship between the natural period of a structure and the ground on which it rests. The predominant period of a building generally relates to its height. Tall buildings have a long period (2 or more seconds) and thus are subject to greater damage where they are founded on soils with a long period, such as thick water-saturated sediments. Conversely, 1 or 2 story buildings with a shorter period on firmer ground may experience damage from shaking. However, other factors may contribute significantly to damage potential (magnitude, distance, frequency, and duration of the earthquake).

Measures to lessen earthquake damage usually are directed toward preventing damage to structures from ground shaking. Success of these measures depends upon the accuracy of the estimates of the type and intensity of ground motion. In the search for a better understanding of

how earthquakes are generated and for more reliable methods of predicting their effects, the U.S. Geological Survey has undertaken a broad range of earthquake studies in the San Francisco Bay Region. As an adjunct ot these studies, the Survey has determined the anticipated ground response to a large magnitude earthquake of various sites in the Shoreline area. Using refraction seismic data to determine the thickness and characteristics of the subsurface strata, the natural periods of vibration were determined with a computer program.

The significance of the high anticipated acceleration can be learned from the 1971 San Fernando earthquake where the acceleration imparted to structures averaged 0.3G, far above present design parameters. If the vibratory motion of the earthquake had lasted a few moments longer, a major catastrophe would have occurred as many structures failed.

During an earthquake, damage can be extensive to streets, sidewalks, and particularly utilities in areas underlain by soft, water-saturated sediments. In general, utility systems have not fared well during earthquakes since rigid pipes have a tendency to shear. In the 1906 San Francisco earthquake, the three water conduits from the main store reservoirs to San Francisco were destroyed or damaged where they crossed marshy areas. Hundreds of pipe breaks occurred in the city distribution system principally where the lines crossed filled ground and former swamps. Thousands of service pipes were probably broken by earthquake motion. The cost of repairing or replacing streets, sidewalks, roads, and utilities damaged in an earthquake constitutes a major expense to the utility companies, the municipalities affected, and ultimately the taxpayer. On the other hand, the cost of putting in utilities properly to minimize the potential seismic damage, such as using flexible couplings, would sharply increase development costs in areas underlain by bay mud. Property owners in areas that have suffered severe earthquake damage, such as the San Fernando Valley, generally will have their properties reassessed at a lower valuation, reducing their taxes and shifting their burden to the remaining taxpayers in the county.

The area shown on Plate 1 as underlain by bay mud thicker than five feet would be subject to intense ground shaking from earthquakes on the nearby Hayward Fault.

- *Ground Rupture and Lurch Cracking* – Rupture along a fault which begins at the focus may extend to the surfaces as in the recent San Fernando earthquake. Observed movements along the Hayward Fault near the shoreline area are horizontal in nature, and in 1868 was of the order of three feet. The Hayward Fault is also slipping or "creeping" at a measurable rate along parts of its recent trace.

There is insufficient evidence to suggest that there may be some offshoot or branch of the Hayward Fault buried beneath the shoreline area, and the potential for surface rupture, which appears remote, cannot be assessed without additional evidence.

While ground rupture due to movement along a fault appears to be remote, the possibility of lurch cracking is quite high. The younger muds are capable of being deformed by the passage of surface earthquake waves resulting in all types and sizes of irregular fractures, cracks, and fissures in any stiff soil or fill placed over the mud.

Accounts of the October, 1868 earthquake that did extensive damage to Hayward tell of ground waves near Roberts Landings and on the plain that resembled high waves of the sea. Cracks were seen in the soil from which water and sand were ejected.

- *Tsunamis* – Earthquakes generate large waves that travel across oceans and build to great heights to cause damage to coastal cities. The northern coast of California has experienced damage from tsunamis generated by earthquakes in Alaska. However, the effects of such sea waves are dissipated in San Francisco Bay, and the potential for damage to the shoreline area is negligible.

Planning Implications

In the Hayward Shoreline Area there are areas more geologically stable and therefore more suitable for development than others.

The area underlain by the older alluvial sediments and no bay mud are developable without special engineering considerations.

The areas underlain by bay mud of five feet or less can be developed with proper engineering controls and rigorous inspection.

Development should be discouraged in the areas underlain by bay mud more than five feet in thickness. Problems in development are related to the propensity for damage to structures from differential settlement caused by static loading or earthquake shaking.

The Hayward Shoreline Area is located in one of the most seismically active areas in the nation and can be expected to experience earthquakes of magnitude 6.5 every 50 to 100 years.

Because of the high seismic activity and weak foundation soils, the stability of existing levees in the study area during an earthquake is questionable.

Should development be permitted on the tidal lands underlain by thick bay mud, the inadequacy of existing building codes and inspection control would lead to high economic costs as the result of considerable damage during a major earthquake. The most serious damage would be to underground utilities that would be ruptured from severe ground motion. The cost of repairing the utilities is borne by the taxpayer. In addition, as a consequence of an earthquake disaster, the sufferer is given financial assistance in the form of reduced property taxes, thereby increasing the tax burden of the rest of the Alameda County property owners.

Soils

Introduction

Although the primary purpose of the work done by the Soil Conservation Service is to assess the agricultural suitability of soils, much of the same data are relevant inputs for planning considerations. Therefore, a map and survey of the various limitations involved in soil properties would indicate the kinds of problems that may be expected if development is considered. For example, one consideration may result from a lack of drainage where high water tables necessitate expensive drainage facilities. Such information about soil can aid expanding cities to avoid construction failures or enable them to take advantage of more suitable areas. To make a description of soil limitations more meaningful, however, a basic understanding of soil characteristics and a general orientation to the soil types found in the shoreline area are important.

Soils are naturally occurring complexes of silt, sand, clay, minerals, and organic materials occurring on the earth's surface. They range from several inches to many feet in depth and have varying amounts of moisture content. Soil properties can differ markedly from place to place as the processes that produce soils vary in intensity with time and location. For example, climate affects soils through temperature variation and the kind and amount of precipitation. Slope or degree of steepness of the terrain influences external and internal drainage. Vegetation and living organisms produce organic material and contribute to chemical weathering. Parent material or underlying bedrock are key determinants of a soil's texture as well as mineralogic and chemical composition. Soils consisting of horizons of similar character and arrangement, as well as similar materials, are grouped by soil scientists into major categories known as soil series, which are subdivided into subcategories referred to as soil types. In a particular series, all soils having a surface layer of the same texture (ranging from fine to coarse) belong to one type.

In the Hayward Shoreline Area there are eight individual soil types which constitute the major soil series that cover the study area.

For this study, the soil types have been grouped into three soils environmental units that have slightly differing characteristics, and are shown on Plate 2: Silty Clay Surface Soils; Silty Clay Surface Soils (which are less saline); and Clay Loam Surface Soils.

The soil properties significant to engineering properties are presented in Table A. The interpretation of these properties is presented in Table B.

Soil Limitations That Affect Development

A discussion of some of the more significant limitations that affect the shoreline area for development follows:

- *Soil Permeability* – A measurement of a soil's ability to transmit water is expressed by the rate of percolation or the time taken for a given amount of water to seep into the soil. All the soils in the Shoreline Area display slow-to-very slow rates. Slow percolation rates suggest the use of package treatment plants or conventional sewer trunk lines rather than septic tanks. Although the percolation rate of soils is traditionally the main criteria by which septic tanks are sanctioned, there are many other factors which must be considered in relation to such means of on-site sewage disposal, such as soil depth, degree of slope, water table, soil drainage, and certain geological conditions. The Department of Agriculture, Soil Conservation Service, has classified all the soils in the Shoreline Area as having severe septic tank limitations. These limitations are based on such findings as: (a) poor percolation rates; (b) poor drainage; and (c) less than five feet to a permanent water table.

- *Shrink-Swell Potential* – This feature of a soil relates to a volume change with changes in moisture content. This condition can cause damage to building foundations, roads, and other structures due to the shrinking and swelling of soils as a result of alternate wetting and drying. Soils of high potential for shrink-swell behavior usually include clay loams and montmorillonitic clays. Montmorillonite is a clay mineral derived from altered volcanic rocks. There are also soils that display variation in the usual shrink-swell behavior by shrinking greatly while drying but that do not swell on rewetting. On level lands, soils that contain clays associated with

TABLE A — ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Soil Series Name and Map Symbols	Depth to Water Table	Classification of Soil Layers				Permeability in./hr. of soil	Available water-holding Capacity* in./in. soil	Reaction pH	Salinity (Conductivity in Millimohs per cm.)	Shrink-Swell Potential	Corrosivity	
		Depth from Surface	USDA Texture	Unified	AASHD						Uncoated Steel	Concrete
Alviso silty clay, 0 to 2 percent slopes (AUA)	Less than 3″	0-39″ 39-45″	silty clay silty clay loam	CH CL	A-7 A-7	.05-.20 .20-.80	.11 .13	6.0 4.0	16 16	High Moderate	Very high Very high	Moderate High
Alviso silty clay, drained, 0 to 2 percent slopes (AVA)	3′-5′	0-39″ 39-45″	silty clay silty clay loam	CH CL	A-7 A-7	.05-.20 .20-.80	.13 .13	6.0 4.0	8-16 16	High Moderate	High High	Moderate High
Alviso silty clay, ponded, 0-2 percent slopes (APA)	Surface	0-39″ 39-45″	silty clay silty clay loam	CH CL	A-7 A-7	.05-.20 .20-.80	.11 .13	6.0 4.0	16 16	High Moderate	Very high Very high	Moderate High
Clear Lake clay, 0-2 percent slopes (CLA)	Over 4 ft.	0-48″ 48-72″	clay silty clay	CH CH	A-7 A-7	.05-.20 .05-.20	.15 .15	7.0-8.2 8.2	2 2	High High	Very high Very high	Low Low
Danville clay loam, 0-2 percent slopes (DNA)	Over 5 ft.	0-8″ 8-28″ 28-72″	clay loam clay clay loam	CL CH CL	A-6 A-7 A-6	.20-.80 .05-.20 .20-.80	.19 .15 .18	7.0 8.0 8.2	2 2 2	Moderate High Moderate	Moderate Moderate Moderate	Low Low Low
Omni silty clay loam, 0-2 percent slopes (OMA)	3′-5′	0-11″ 11-23″ 23-47″	silty clay loam silty clay silty clay loam	CL CH CL	A-7 A-7 A-7	.05-.20 .05-.20 .05-.20	.18 .15 .18	8.0 8.0 8.0-4.5	2-4 2-4 2-4	Moderate High Moderate	High Very high Very high	Low Low Low
Willows clay, 0 to 2 percent slopes (WLA)	Over 4 ft.	0-60″	clay	CH	A-7	.05-.20	.13	8.0-8.2	4-16	High	Very high	Low

TABLE B— INTERPRETATIONS OF ENGINEERING PROPERTIES OF SOILS

	Degree and Kind of Limitation for						Suitability as Source of –			Soil Features Affecting –	
Soil Series and Map Symbols	Septic Tank Adsorption Fields	Sewage Lagoons	Shallow Excavations	Dwellings without basements	Sanitary Landfill (Area-Type)	Local Roads and Streets	Road Fill	Topsoil	Cover Soil for Area Sanitary Landfills	Pond Reservoir Areas	Embankments (compacted)
Alviso silty clay, 0-2 percent slopes (AUA)	SEVERE-slowly permeable, high water table	SEVERE-water table at approximately 3 ft.	SEVERE-high water table, clayey texture	SEVERE-high water table, high shrink-swell	SEVERE-water table at about 3 ft.	SEVERE-poor drainage	POOR-clayey texture	POOR-excess salt	POOR-wet clayey soil	High water table	Low shear strength Possible piping Fair to poor compaction
Alviso silty clay, drained, 0 to 2 percent slopes (AVA)	SEVERE-slowly permeable, high water table	MODERATE-water table at 3′-5′	SEVERE-clayey texture	SEVERE-high shrink swell	MODERATE water table 3-5′	SEVERE-CH unified classifcan	POOR-clayey texture	POOR-excess salt	POOR-wet clayey soil	High water table	Low shear strength Possible piping Fair to poor compaction
Alviso silty clay, ponded, 0 to 2 percent slopes (APA)	SEVERE-slowly permeable, high water table	SEVERE-water table at surface	SEVERE-high water table, clayey texture	SEVERE-high water table, high shrink-swell	SEVERE-water table at surface	SEVERE-water table at surface	POOR-clayey texture	POOR-excess salt	POOR-wet clayey soil	High water table	Low shear strength Possible piping Fair to poor compaction
Clear Lake clay, 0-2 percent slopes (CLA)	SEVERE-slowly permeable	SLIGHT-where water table is over 5 ft; MODERATE where water is less than 5 ft.	SEVERE-clayey texture	SEVERE-high shrink-swell	MODERATE poor internal soil drainage	SEVERE-high shrink-swell	POOR-clayey texture	POOR-clayey texture	POOR-clayey soil	Slowly permeable; possible water table 5′	Medium to low shear strength High compressibility
Danville clay loam, 0-2 percent slopes (DNA)	SEVERE-moderately slowly to slowly permeable	SLIGHT	MODERATE-clay loam texture: light clay texture in subsoil	MODERATE-moderate shrink-swell	SLIGHT	MODERATE CL Unified Classification	FAIR-Unified Classification of CL	FAIR-clay loam texture	FAIR-clay loam texture	Moderately slowly to slowly permeable	Medium to low shear strength
Omni silty clay, 0 to 2 percent slopes (OMA)	SEVERE-slowly permeable, high water table	MODERATE-water table at 3′ to 5′	SEVERE-clayey texture	MODERATE to SEVERE moderate to high shrink-swell	MODERATE-water table at 3′ to 5′	SEVERE-CH Unified Classification	POOR-clayey texture	POOR-clayey texture	POOR-clayey soil	High water table	Medium to low shear strength High compressibility
Willows clay, 0 to 2 percent slopes (WLA)	SEVERE-slowly permeable	SLIGHT-where water table is over 5′; MODERATE where water table is less than 5′	SEVERE-clayey texture	SEVERE-severe shrink-swell	MODERATE-poor internal soil drainage	SEVERE-high shrink-swell	POOR-clayey texture	POOR-clayey texture	POOR-clayey soil	Slowly permeable; possible water table at 5′	Medium to low shear strength High compressibility

shrink-swell behavior can be sites for structures provided foundations are designed and built to resist soil shifting.

Shrink-swell potential for the study area is classified as moderate to high for all the soil types.

- *Water Table* – Those soils which are in areas of either high or intermittently high water tables could limit absorption or effluent from septic tank filter fields. In addition, the need for protection foundations, basements, and underground utilities against damage due to seepage may be an additional cost consideration.

In the Shoreline Area, the only soil with the water table at depths greater than five feet is the clay loam (USDA soil classification DNA). For the rest of the area, water tables are at the surface or at less than five feet in depth.

- *Other Soil Limitations* – The on-site inspection of soils for specific development purposes should include the examination of several other soil characteristics that may affect development costs or designs. One example is soil corrositivity. Materials such as metal and concrete pipes corrode when buried in soil, and a given material will corrode more rapidly in some soils than in others. The degree of corrositivity is related, of course, to the specific structural material. For untreated steel pipe, for example, there are five degrees of limitations. The most important factors in corrositivity are total acidity and electrical resistivity of soils. Since some materials corrode in some soils more rapidly than in others, costly replacement operations may be necessitated before the calculated economic life of a material is achieved.

Soils with excessive amounts of alkali or soluble salts can have a toxic or retarding effect on the growth of exotic plants. These salts consist of sodium bicarbonate and sodium carbonate which are commonly referred to as black alkali. Soils strongly affected by these salts are difficult to reclaim, and plant yields are usually low.

A factor of considerable engineering importance to be examined in a specific location is the bearing capacity of a soil. Some soils do not supply sufficient support for heavy loads and are subject to slippage. Such failures can cause breakup in roads and building foundations. Often a soil's strength will undergo changes with changing conditions of wetness and dryness. Usually, soils underlain with hard bedrock or stiff clay have less bearing capacity limitations. High shrink-swell clays and soils with high but varying amounts of organic material will have higher limitations. That is, such soils are capable of standing fewer pounds per square foot of pressure.

Planning Implications

As indicated on the tabulation, practically all of the soils in the shoreline area have qualities which limit their ability to absorb effluent from septic tanks, dictating the use of some other method of sewage disposal.

The soils in the study area are not well suited for agricultural uses, other than grazing. Other soil limitations are in the soils having a high shrink-swell potential. Houses built in this area require specially engineered and constructed foundations. High water tables likewise suggest the need for special foundation work.

Hydrology

Instroduction

Adequate collection and disposal of surface water runoff are important considerations to the Shoreline Area as one means of protecting against flood damage. Flood control channels and sloughs carry the flood waters through the area and gradually become filled with sediments that require dredging.

Much of the Shoreline Area was subject to natural tidal action prior to the 1900's. Since then, a system of dikes and levees for agriculture and salt production was built. Today, with flood control works and the dikes and levees, flooding has been virtually eliminated.

Removal of the dikes would restore the potential for flooding from tidal action most of the area.

Tides and currents in the Bay affect the sedimentation in the flood channels and the potential for flooding.

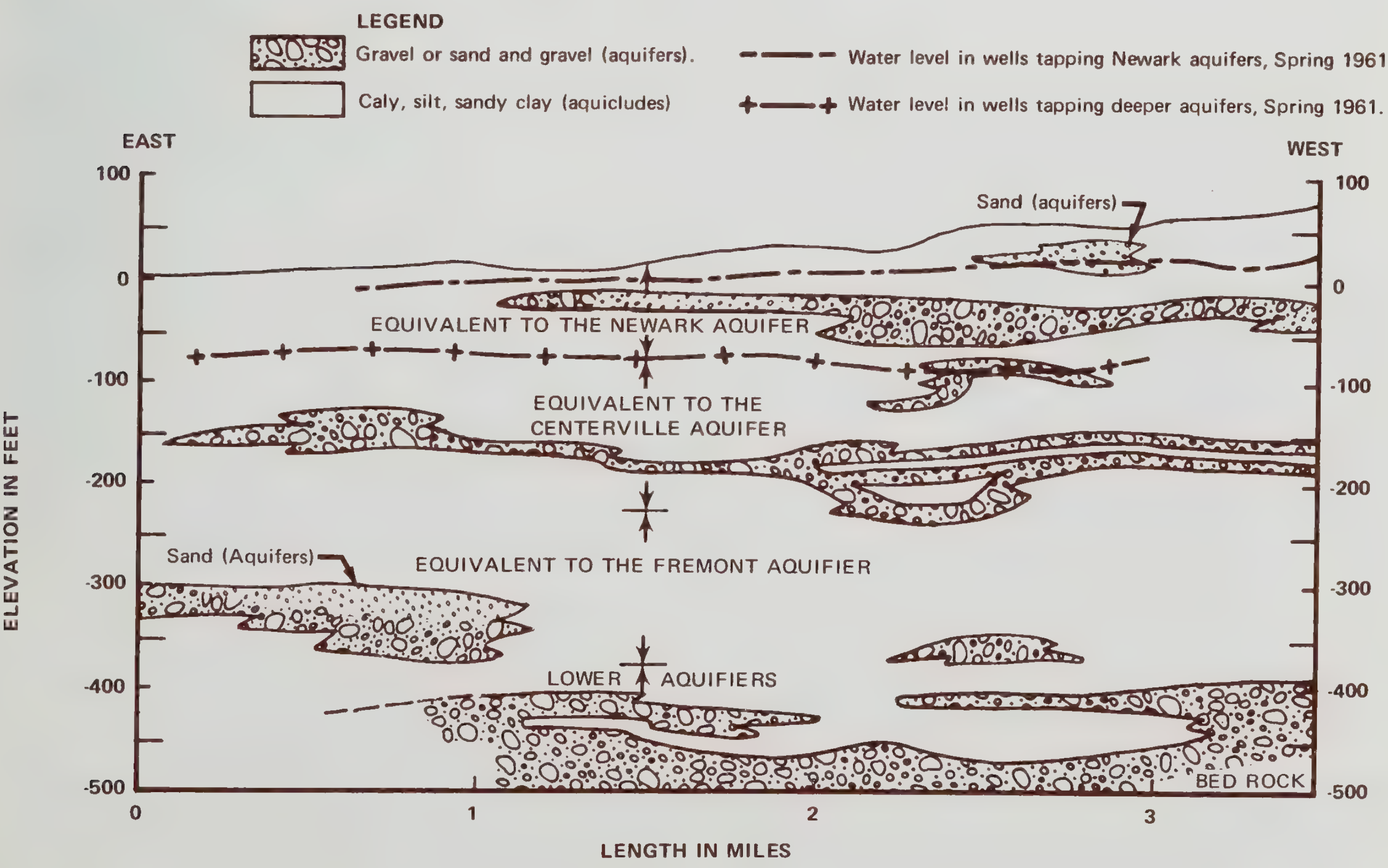
Floods

During heavy rains, some water soaks into the Hayward Hills area. The remainder, an estimated 100,000 acre feet, runs off annually into streams and channels that ultimately empty into the Bay.

Before civilization extended into this area, the bay plain stretched uninterrupted into the bay, with mud flats inundated by bay waters at high tide and exposed at low tide. The historic tidal zone is shown on Plate 3.

Prior to 1900, land owners began construction of levees or dikes in the tidal flats to reclaim land for agriculture and to create salt ponds as the start of a thriving salt production industry. The diking process continued into the 1950's, with only minor additions and revisions made in recent years. The dikes prevented the bay waters from washing over the tidal and marsh areas, and prevented flood waters from flowing freely into the bay. Flood waters used to overflow streams and back up against dikes in the shoreline zone.

TYPICAL SUBSURFACE SECTION ACROSS STUDY AREA



Flooding from runoff has been controlled subsequently by dams and storm channels. However, flooding from salt water inundation is controlled only by the stability of the present dike system. In the event of dike removal or failure, the area that would be inundated by a combination of high tide, heavy wind and rain, lies below seven feet in elevation above mean sea level. That area is shown on Plate 3.

Developments that may take place below the historic tide line in the area underlain by less than five feet of mud would require provision for drainage during heavy storms and high tides. Ordinarily, this would be provided for by a pumping plant to lift the waters to a higher elevation outlet; or by a ponding area with drain pipes and tide gates that would permit the waters to flow out as the tides recede; or by filling the area above the outlet level to permit runoff by gravity; or by a combination of any or all of these methods.

In Foster City, San Mateo County, which is below sea level, pumping plants, which is the least desirable method from an operational standpoint, are used.

Siltation

The flood control channels and sloughs which carry flood waters become filled gradually with silt eroded from the hills and suspended material that moves in from the bay. The silt is removed periodically to keep the channels open. The estimated average annual quantities of silt which must be dredged from the various channels in or adjacent to the Shoreline Area approximates 45,000 cubic yards per year.

Since siltation is a natural process, the removal and deposition of the silt is a recycling procedure. Problems arise in the disposal of dredged material, and disposal sites near the silted area are desirable from an operational standpoint. The dredged silt could be used to create areas for growing marsh grass, resting areas or habitats for wildlife, or other conservation purposes; transported and deposited inland of the salt ponds; or transported by barge to recognized disposal areas in the bay or ocean.

Ground Water and Subsidence

Intensive pumping of the ground water supply has lowered the water table and permitted salt water to gradually intrude into the water basin under the bay plain. Because of the impermeable nature of the silty clay on the bay plain, very little fresh water could percolate through it, and the salt waters of the bay have saturated the clays and silts along the shoreline.

In the south end of the bay, extensive pumping of the ground water from the underground reservoir has resulted in subsidence of the land surface. This has created a problem in maintaining the level of the dikes to prevent flooding. In the Shoreline Area, the amount of land subsidence has been negligible and, therefore, is not a critical factor to this study.

Salt Ponds

Salt ponds encompass almost ten square miles of the Shoreline Study Area. They are of significance to the climatic conditions, the ecology, and the hydrologic cycle.

In the San Francisco Bay, there are three factors favorable to the manufacture of salt by solar evaporation. First, the dry climate, lack of rain during the summer, and summer winds cause high evaporation. Second, the thousands of acres of salt marsh provide low-lying land on which the necessary large acreage of evaporating ponds may be built. The marshes are at or close to sea level, which minimizes pumping, and the clayey soil provides natural water-tight bottoms that minimize leakage. Finally, the industries of the Bay Area constitute a ready market.

The solar evaporation process requires pond areas of 400 to 500 acres each. Over a period of three to four years, the brine is moved from pond to pond as it becomes more concentrated. After the winter rains, the concentrated brine, containing about 21.5% salts, is run through a series of crystallizing ponds where continued evaporation causes salt to form and fall to the bottom.

At the end of the evaporating season, the crystallizing ponds are drained and the crude salt that has formed on the bottom is broken up and loaded into cars. From four to six inches of salt forms during the evaporating season. After harvesting, the crude salt is stockpiled and the bottom of the pond recompacted with rollers to ensure that the ponds are effectively sealed off from the underlying water table.

The outboard dikes forming the salt ponds were constructed of native material, the silty clay, and are maintained by the operator, Leslie Salt Co. The dikes are not designed for flood control and would need strengthening to protect any inland development other than salt ponds. Since the levees are maintained by the owner, if they were abandoned, the areas below seven feet in elevation (mean sea level), would be subject to flooding by tidal action. The salt ponds have no drainage as such, and they are programmed to be inundated with tides, taking into account any additional water from rain, and the water then evaporated. If salt production was stopped, some government agency would have to maintain the levees, which could easily be destroyed without constant vigilance.

SALT IS PRODUCED BY SOLAR EVAPORATION FROM PONDS IN SAN FRANCISCO BAY.

Sewage Disposal

Since sewage is normally handled by gravity lines, the low-lying tidal lands create problems in sewage disposal. Expensive pumping plants are required to pump the raw sewage to treatment plants. The bulk of the Shoreline Area is underlain by poorly draining soils or a high water table that dictate the use of such plants.

Tides and Currents

Introduction

The sea level of the Pacific Ocean and the San Francisco bay system rises and falls with two highs and lows each day in response to the gravitational pull of the sun and moon. The rise and fall are known as the tides, which may vary locally due to wind and barometric pressure.

Tide elevation and range vary throughout the Bay, with the tides higher in the south end of the Bay than in the north. The highest estimated tide increases one foot one inch between Roberts Landing north of San Mateo Bridge and Dumbarton Bridge.

Tidal action and bottom topography are the most important factors creating currents; others are fresh water inflow and wind. Tidally induced currents have two flood and two ebb phases. The currents through the Golden Gate are stronger than elsewhere and decrease with increasing distance from the Golden Gate.

The average maximum velocity of ebb and flood currents in the Shoreline Area reaches 2.5 to 3.0 feet per second. However, the general circulation and the net flushing are poor. The currents serve to disperse wastes that contain heavy metals, pesticides, and nutrients, and are important for moving sediment. Changes in current direction will cause some areas to shoal and others to scour.

NET FLOW PATTERN UNDER NORMAL SUMMER CONDITIONS

Of particular importance to the Shoreline Area are the north-flowing net currents which are essential to the dispersion of effluents released in the south bay.

Shoreline projects can affect the currents and, if the project is large enough, the tides. For example, mudflat areas could be extended by increased sedimentation or reduced by erosion. Under existing conditions, the shoreline is smooth, without embayments; currents generally run parallel to the shore with essentially no stagnation.

Projections such as solid-fill jetties would create slack water areas for sediment accumulation and hinder the transport of pollutants out of the bay. During the summer, losses from evaporation may exceed inflows from creeks and outfalls and the flushing rate is especially low. Dye released near the San Mateo Bridge by State engineers, was still detected in the south bay after three weeks. Fills creating embayments or impeding currents could further slow this flushing.

EFFECTS OF CONSTRUCTION ACTIVITIES:

- *Large Fills* – Studies by the Corps of Engineers have shown that large fills in the bay from the shoreline to minus 6 or minus 12-foot depths would have detrimental effects on the circulation and flushing and the ability of the bay water to assimilate waste.
- *Marinas* – Marinas would require dredging, and, where protected by jetties, periodic maintenance dredging. A marina exposed to the open bay may need a breakwater for protection from high waves. Slopes will also require protection from the erosive power of waves.
- *Jetties, Outfalls, Piers and Docks* – These structures may affect currents and deflect them in new directions, causing areas of sedimentation.
- *Dredging* – New dredging generally creates a need for maintenance dredging. Deepened channels tend to return to their original depths and configurations.
- *Marshes and Fills* – Shores will need slope protection to prevent erosion. New fills can have a tremendous impact on existing conditions. Currents can be deflected, sediments may be scoured and redeposited, and northward-flowing currents could be reduced, creating slack water areas.

FLOOD CONTROL WORKS

Tides affect flow conditions in flood channels by raising or lowering the water surfaces. At high tide, the water surface elevation must be built high enough to contain predicted flood flows combined with high tides. The Alameda County Flood Control and Conservation District designs flood channels by adding one foot (to allow for build-up due to wind) to the highest tide of record combined with flood flows calculated from storms predicted once every five years. The highest tide is estimated at nearly 7 feet above mean sea level. The existing flood control channels are subject to tidal action that reaches almost to the easterly boundary of the study area. Levees built to protect low-lying areas from tidal flooding are usually built at least one foot higher than the estimated highest tide.

SALT PONDS AND DIKED DRY LAND

It is possible that when ponds are no longer needed for salt production that the dikes could be breached, restoring this land to tidal action. This would have beneficial, but not significant, effects upon the tides and currents in the bay. Flow in and out of the pond area would be primarily in an east-west direction, following the existing pattern of sloughs. The effect on north-south currents would not be great. If the outboard dikes are breached, inboard dikes although not subject to the same intensity of erosion may need to be strengthened to provide flood protection for low-lying inland developed areas.

Wave actions and currents are continually eroding the unprotected dikes and, without continuous maintenance work, they will eventually wash away. Inboard dikes exposed to wave action from the open bay would also erode, the eroded material filling the bay.

Planning Implications

The construction of facilities such as jetties, piers, outfalls, marinas and islands can have a significant effect on the hydraulics of the Hayward Shoreline Area.

Planning for shoreline facilities must take into account the characteristics of tide and currents,

exposure to wave action, and the need for maintenance. Maintenance dredging should be anticipated in channels and harbors. Plans should be made for soil disposal that will not be harmful to the environment.

The low-lying tidal lands necessitate expensive pumping plants to remove raw sewage to treatment plants.

The return of the diked salt ponds or dry lands to tidal action will increase the tidal prism in the bay, and may improve the circulation and flushing of the south bay.

Return of the salt ponds to tidal action will remove the flood protection of the existing levees. Inboard dikes would have to be strengthened to prevent flood damage. If production of salt ceases, a public agency would have to maintain the levees to prevent them from being destroyed.

The consequence of development on the lands protected by levees has been succintly summarized by Tudor Engineering Company in their Baylands Salt Water Flood Control Planning Study for the Santa Clara County Flood Control and Water Districts:

> *"Building on lands protected by any of the levee systems considered in this study would be done at the risk of destruction of a levee section by a major earthquake. Under all plans it is assumed that a major earthquake could rupture the levees and enable fresh and salt water flooding to take place. Under these circumstances, to construct levees which under all other circumstances protect low-lying lands from flooding may lead to new developments on the "protected" land and to great loss of property and of life when an earthquake occurs. On the other hand, to build a protective system at great cost and then let it be known that the land is potentially hazardous would serve to deter development and to make the project less financially practical. In the light of the hazard to the levee system which earthquakes could cause, and the possibility that levees would be breached and flooding would occur, each developer who decided to use the "protected" land probably would resort to either physical measures to protect his structures as he would have done in the absence of the levees, or would seek to shift a part of the risk through insurance. There could be a double burden on such land uses: the burden of helping to support the cost of the new levees, and the burden of either more expensive construction in the areas contained by the new levees, or of payments to insure a part of the risk. If more land is not needed, and those who use the new land may incur heavy costs of development or of insurance, it would appear that construction of protective levees for land development purposes is questionable. Land areas inside and above the inboard levee system would be least vulnerable to earthquake damage and are among those most likely to develop in the normal course of events. They are also the areas most likely to be able to bear the burden of additional levee protection."*

Climate

Introduction

The Hayward Shoreline Area's microclimate has the same gross characteristics as the overall San Francisco Bay: a mild, year-round temperature, abundant rainfall in the winter, and almost no rain in the summer.

The natural basin created by San Francisco Bay and the surrounding mountain ranges, coupled with prevailing westerly winds and high summer temperatures, lead to atmospheric conditions that contribute to air pollution.

Except for their effects on air pollution, the climatic factors are significant to the Shoreline Area only in relationship to other physical and biological factors such as soil, hydrology, and vegetation. However, climate does have some bearing on the uses, especially recreational, to which land can be put.

Temperature

Year-round temperatures are mild along the Shoreline Area. The mean temperature between the warmest and coldest months of the year is only 15° F. The air temperature of the Shoreline Area is regulated by west winds and the San Francisco Bay in the summer when the mean daily temperature is 64.9° F. The daily mean maximum temperature is 75.7° F. and minimum is 54.1° F.

In winter, the mean daily temperature of the Shoreline Area is 48.2° F., with a daily mean maximum of 57.9° F., and daily mean temperature of 38.4° F.

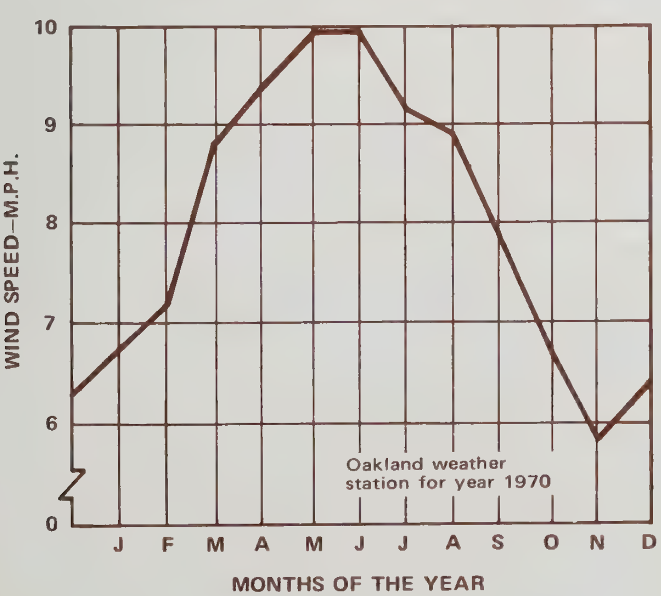
Winds

Winds are highest in the summer, but peak winds of 40 miles per hour or more are reached in the winter during Pacific storms.

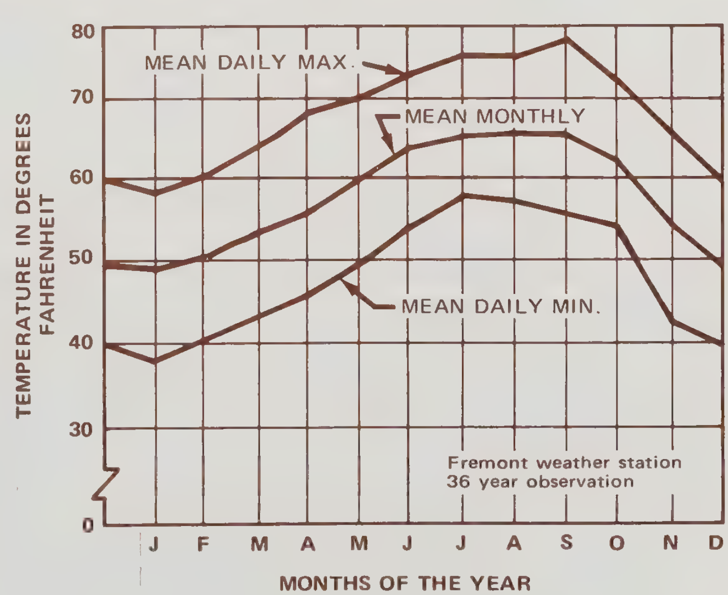
The predominant summer winds come from the west and northwest at an average speed of 9.8 miles per hour. These winds flow through the Golden Gate and Crystal Springs gaps in the Coast Ranges. The winds' speed ranges from 4 to 18 miles per hour over a 24-hour period. The maximum speeds are reached at the same time that the highest temperatures occur, between 1 P.M. and 7 P.M.

In winter, wind blows from all directions, with the most prevalent direction from the Santa Clara Valley to the southeast. The average wind speed at this time is six miles per hour, except when the Pacific storms hit and speeds can exceed 40 miles per hour.

AVERAGE (MEAN) MONTHLY TEMPERATURES



AVERAGE (MEAN) MONTHLY WIND SPEED



Precipitation

The Shoreline Area has abundant rains in the winter and little or no precipitation in the summer. The study area is on the lee side of the Santa Cruz and San Bruno Mountain ranges. Storms are brought to the Bay Area coast by prevailing westerly winds. Some portions of the storms gain entry to the Bay and its tidelands through the Golden Gate and San Bruno Mountain gaps. The amount of precipitation decreases on the lee side of the mountain ranges, to the Shoreline Area, where a mean annual 14.8 inches is recorded. The mean summer precipitation is only 1.45 inches.

Fogs and Clouds

During the summer, the Bay Area's well-known fog moves inland to cover periodically the Shoreline Area. Because of the topography, the low-lying fogs can gain entry only through the mountain gaps, and, as the fog continues eastward, it is burned off by higher inland temperatures. The cool waters of San Francisco Bay prolong the existence of the fog which moves in daily, weekly, and seasonal cycles. The maximum inland penetration of the fog is in August.

The typical summer condition is high stratus clouds which burn off by 10:30 A.M. and return again around 10:30 P.M. For the most part, the Shoreline Area is fog-free in the wintertime.

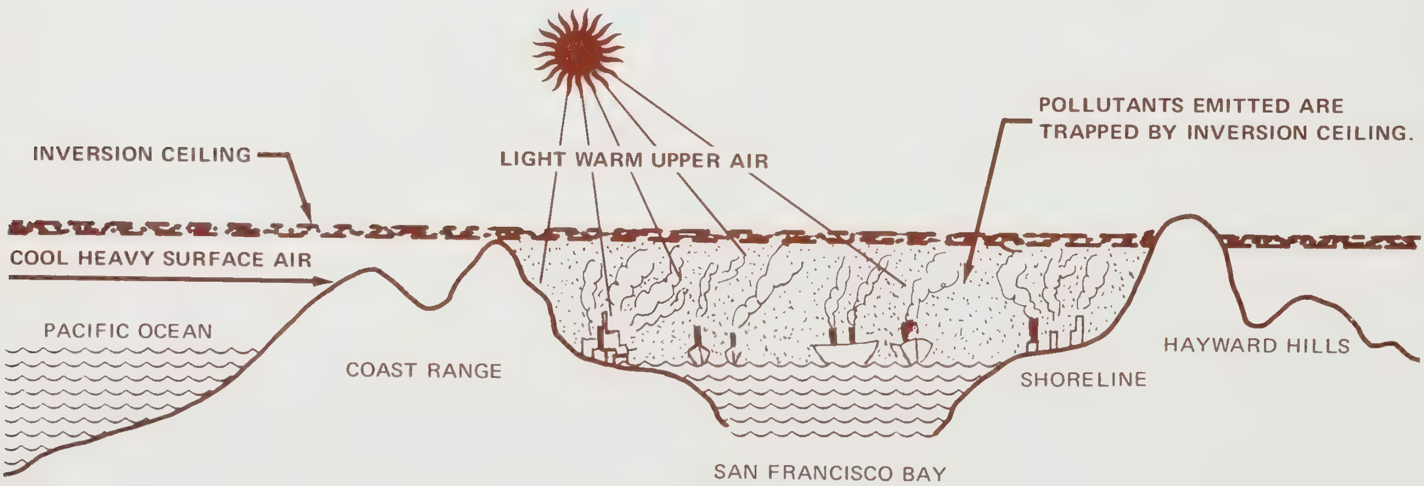
Cloud cover increases during the winter when storms move in over the area from the Pacific Ocean.

Air Pollution

During the summer, the heavier cool, dense air moving inland over the Pacific Ocean is unable to rise and mix with the lighter warm, less dense air above. This phenomenon, plus the topography of the natural basin of the Bay and the surrounding mountains, creates what is known as an inversion layer. Pollutants released into the cool, dense surface air cannot escape the lower atmosphere by mixing with air in the higher atmosphere and are removed by being blown away by prevailing winds.

During the summer, the winds blow predominantly toward the Hayward Shoreline. As a result, Hayward experiences more smoggy days than other Bay Area communities to the north. The oxidant level in the air over the Shoreline Area exceeded the Federal Standard of .10 parts per million, 26 days during the summer months, of which eight days were in excess of 0.15 parts. According to the Bay Area Pollution Control Board, any area that has an oxidant level of .10 parts per million more than ten days a year is considered a hazardous area.

SAN FRANCISCO BAY AREA INVERSION LAYER



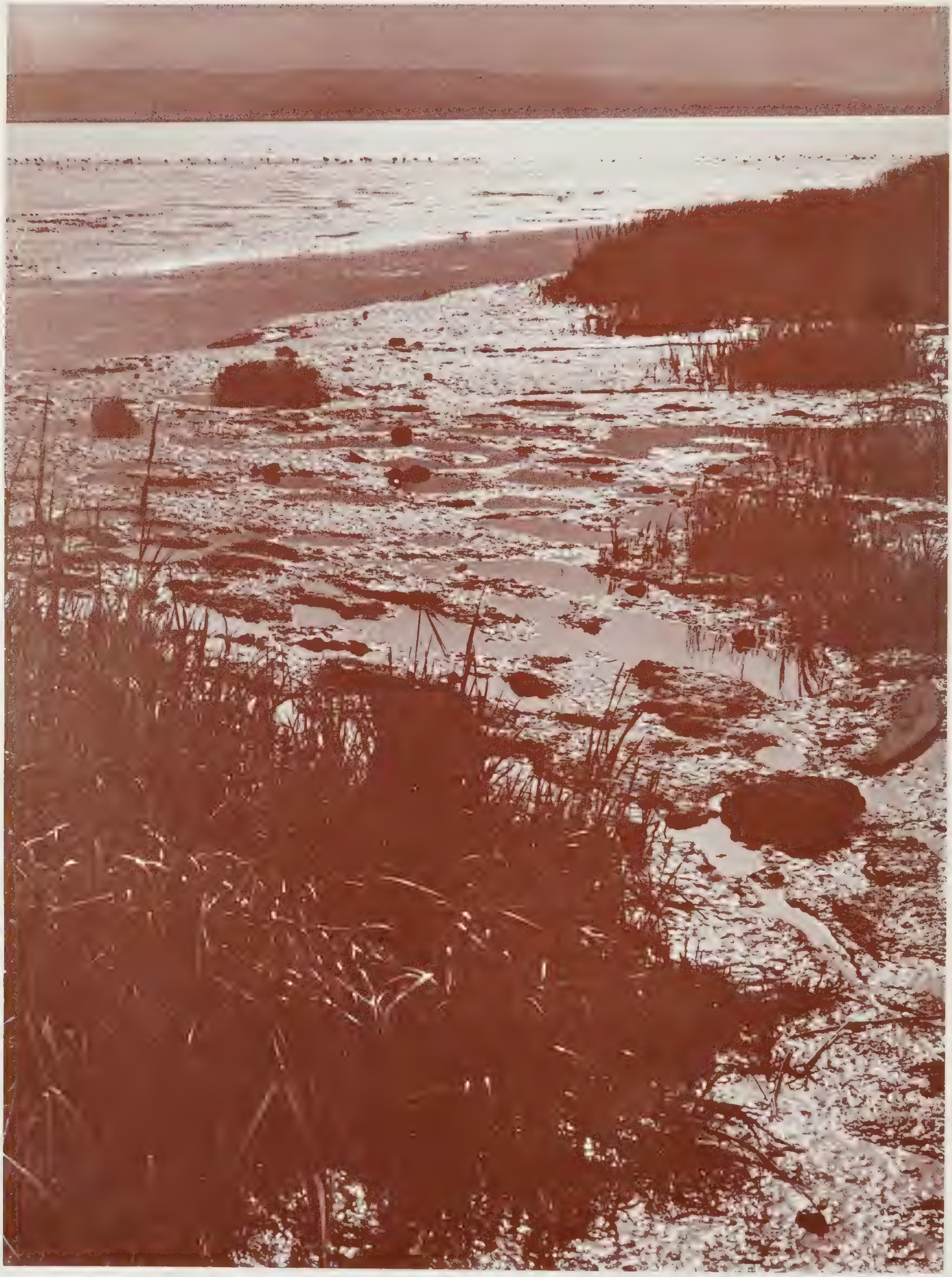
If wind velocities over the Bay were to be dramatically reduced, much higher contaminant levels, similar to those of the Livermore Valley which has 84 summer days above the level of .10 parts, could be expected.

In winter, air pollution is not as great a problem because the inversion layer is not as pronounced as in summer. However, smoggy days do occur. In the winter months of 1969, the oxidant level in the Shoreline Area rose above .10 parts on six days.

Planning Implications

The existing climatic conditions are fairly uniform throughout the Hayward Shoreline Area. Minor changes can be expected however in the microclimate of the Shoreline and Hayward City area if there is any change in the present land use. Any land use that would entail decreasing the present water areas, such as in salt ponds, could result in slightly elevated temperatures, lower wind velocities, and reduction in air circulation. This would tend to increase the number of smoggy days experienced.

In addition, the climatic factors are significant in determining the types of feasible recreation uses, and to the salt production industry. The prevailing winds are also important since they would transmit odors from uses that might be established.



Ecology - by John Werminski

Introduction

Historically, most of the Hayward Shoreline Study Area was subject to tidal action, either as mudflats or salt marsh. The remainder were uplands probably covered with grassland or brush. Old accounts tell of abundant marine life in the Bay, including sea otters and salmon. The present land use is dominated by man's activities; the marine life is vulnerable to man's pollution of the Bay.

Most of the original salt marsh has been diked off from tidal action and thus destroyed. In the portion north of the San Mateo Bridge, the diked areas are mainly dry and are used for sanitary land fill and grazing. In the portion south of the San Mateo Bridge, most of the diked land is in salt ponds.

The shoreline environment or ecosystem (involving the interrelationship of organisms and environment) consists of many parts: open water in the Bay; mudflats exposed at low tides; shoreward stands of cordgrass; and landward, pickleweed. The vegetation serves as the broad food base for marsh and bay animals, and as habitat for many species.

Six different ecosystems have been recognized in the Shoreline Area: *SHALLOW BAY WATER, TIDAL MUDFLATS, SALT MARSH, SALT PONDS AND DIKES, MINOR MISCELLANEOUS HABITATS* (dry dikes areas and seasonal fresh water ponds, and upland habitats: fields and pastures, isolated hills, and residential-industrial areas).

The distribution of these ecological units is shown on Plate 4.

SHALLOW BAY WATER AND TIDAL MUDFLATS

These two important habitats are represented by some 9,500 acres in the planning area. In some respects the open bay and mudflat areas appear to be distinct entities, but on the other hand they are united by a number of physical and biological circumstances into a larger ecological unit which is difficult to subdivide.

The bay shoreline environment is dominated by a tidal rhythm that consists of two high tides of unequal magnitude and two low tides also of different heights during the course of a 25-hour "lunar day." Although this constant movement of tremendous quantities of salt water affects the open bay, tidal influences are most dramatic along the strip of periodically-exposed mudflats – the intertidal zone.

The shallow bayshore waters of the planning area teem with a wide variety of minute marine organisms that form the first links or base levels of food chains and energy pyramids that eventually incorporate all the larger fish, birds, and mammals that live, feed, and die along the edge of the bay. The microscopic planktonic plant life is dominated by diatoms, with over 25 genera found in San Francisco Bay.

In terms of minute animal life, protozoans are similarly quite abundant – sometimes to the degree of twenty thousand per quart of salt water – and include at least six different genera, mainly ciliated and flagellated forms. In addition, Harvey (1971) recognizes four major groups of planktonic invertebrate animals in the bay that feed on the microscopic marine life and in turn are preyed upon by larger forms. They are (1) polychaete larvae (segmented worms), (2) copepods (crustaceans) – the most abundant, in concentrations of up to 75 per quart, (3) fish larvae, and (4) snail larvae. Also, there are two ecologically important types of shrimp that inhabit the local waters: the Black-tail Shrimp *(Crago nigricauda)*, and the Bay Shrimp *(Crago franciscorum)*, once highly prized for human food.

About 125 species of fish have been reported from San Francisco Bay, some of which are known to be quite abundant. Great numbers of Striped Bass *(Roccus saxatilis)* come through the bay to spawn, as do some Steelhead Trout *(Salmo gairdnerii)*. Certain bait fish like Northern Anchovy *(Engraulis mordax)* and bottom fish like Shiner Seaperch *(Cymatogaster aggregata)* are very numerous as well. While there is evidence that the diversity of fish species decreases southward in San Francisco Bay, at least twenty South Bay fish attain some degree of commonness. Seventy species were found by the California Department of Fish and Game in a 1963-66 study in the central and south parts of the bay. At the closest station, although seven miles northwest of Hayward, from 2 to 17 species were found per month by sample (average 9). Those in greatest numbers were the Northern Anchovy, Pacific Herring, Jacksmelt, Shiner Perch (May, December) and English Sole.

The thriving community of organisms that live on and in the bay muds is a major element of the shoreline environment. Here as in the shallow water, plants and animals range from microscopic to

moderate-sized forms. Many of them serve as initial or intermediate steps or links in chains of food, transfers of energy, and in webs of interrelationship which often extend beyond the muds to the open water or may reach inland to the bay plain.

Like the shallow water, the moist bay muds are inhabited by large numbers of small, relatively simple forms of life. Single-celled blue-green algae may abound on the surface, and types of multicellular red algae and green algae (such as the conspicuous Sea Lettuce, (*Ulva* sp.) may be found in quantity as well. Even so, the chief photosynthetic organisms are probably benthic (bottom-dwelling) diatoms, found within the upper centimeter of the muds.

Well over one hundred species of invertebrates have been collected from San Francisco Bay muds. Among these are certain roundworms (nematodes), ribbon worms (nemerteans), and such segmented worms (annelids) as *Nereis diversicolor* and the Pile Worm, *Neanthes succinea.* Crustacens present in or around the muds include small amphipods (such as *Ampelisca milleri*), commercial crabs *(Cancer magister),* and Shore Crabs *(Hemigrapsus oregonensis),* with barnacles *(Balanus spp.)* living on nearby objects. The east shore community of burrowing animals includes a number of molluscs — both "filter feeders" (strainers) such as mussels and clams. the commonest species being the *Macoma Inconspicus,* and "deposit feeders" (that ingest mud) like the California Horn Snail *(Cerithidea californica).*

The complex biological environment that has been outlined above is indispensable for supporting the huge populations of waterfowl that seasonally visit the shallow waters and mudflats of San Francisco Bay. Cogswell (1973) lists 94 species of waterfowl that have been observed in the Hayward shoreline planning area; of these, 72 can be expected in the bay or on the tideflats. They range from rare winter visitants like Whistling Swans *(Olor columbianus)* and Snow Geese *(Chen hyperborea)* that are only irregularly seen to massive flocks of Western Sandpipers *(Ereunetes mauri)* that at times may number one hundred thousand or more.

In many respects the highly-conspicuous waterfowl population seems to dominate the total wildlife picture along the edge of the bay. Annually the Pacific Flyway deposits additional hundreds of thousands of migrating birds to whom San Francisco Bay is a vitally important feeding and resting area. Some pass through in spring and fall, while others stay to winter in the shelter of the bay. When these are temporarily added to the resident breeding waterfowl population, the numbers of birds found locally can attain remarkable proportions: densities of up to twenty thousand shorebirds per shoreline mile have been reported. In all, South Bay shoreline habitats supply food, shelter, and resting places through the winter for perhaps seventy percent of all the diving ducks and shore birds of the Pacific Flyway. The South Bay and within it, the Hayward Shoreline area supports major segments of these large numbers.

While the implications of such sheer numbers can be staggering, the dynamic, ever-changing nature of the waterfowl population is equally as impressive from an ecological point of view. The over-all population is always in a state of flux — a dynamic equilibrium — as the component species alternately arrive and leave to add or subtract their numbers from the total, and so from week to week the waterfowl picture changes in terms of dominant types and relative numbers. Even during the course of a day the shorebirds shift from place to place within a given area as the tidal rhythm superimposes itself upon the longer seasonal cycle.

As was mentioned earlier, waterfowl ecology in our area is inextricably bound to the bayshore muds and shallows with their diversity of invertebrates and fish. Since most waterfowl seem to be capable of detecting differences between the two common shore area habitats, one of the most useful ways to distinguish bay water from tideflats is by a comparison of their bird populations. As a rule, the open bay waters are visited by loons, grebes, pelicans, cormorants, geese, mergansers, phalaropes, and terns, and are also preferred by most diving ducks; when disturbed, several of the "dabbling" ducks will leave shore to congregate in floating "rafts" on the water as well. Conversely, tideflats host herons, egrets, plovers, avocets, stilts, and probing shorebirds.

The environmental importance of the bay water-tideflat complex is considerable. Plant productivity for the mudflats may in places exceed two thousand pounds per surface acre, a figure which — in the absence of pollutants and excessive sedimentation — could even be increased. Together, the phytoplankton and bottom-dwelling vegetation of the water and mud operate as an "interdependent biochemical factory" that harnesses solar energy, releases oxygen, absorbs carbon dioxide and hydrogen sulfides, and fixes carbonates, nitrates, and phosphates. Much of this material is transformed through a variety of channels and organisms to ultimately provide the wealth of invertebrate and vertebrate animal life that characterizes the bayshore environment. The ebb and flow of tides maintain a vital circulation system that disperses nutrients that come from within and beyond the shoreline area.

SALT MARSH

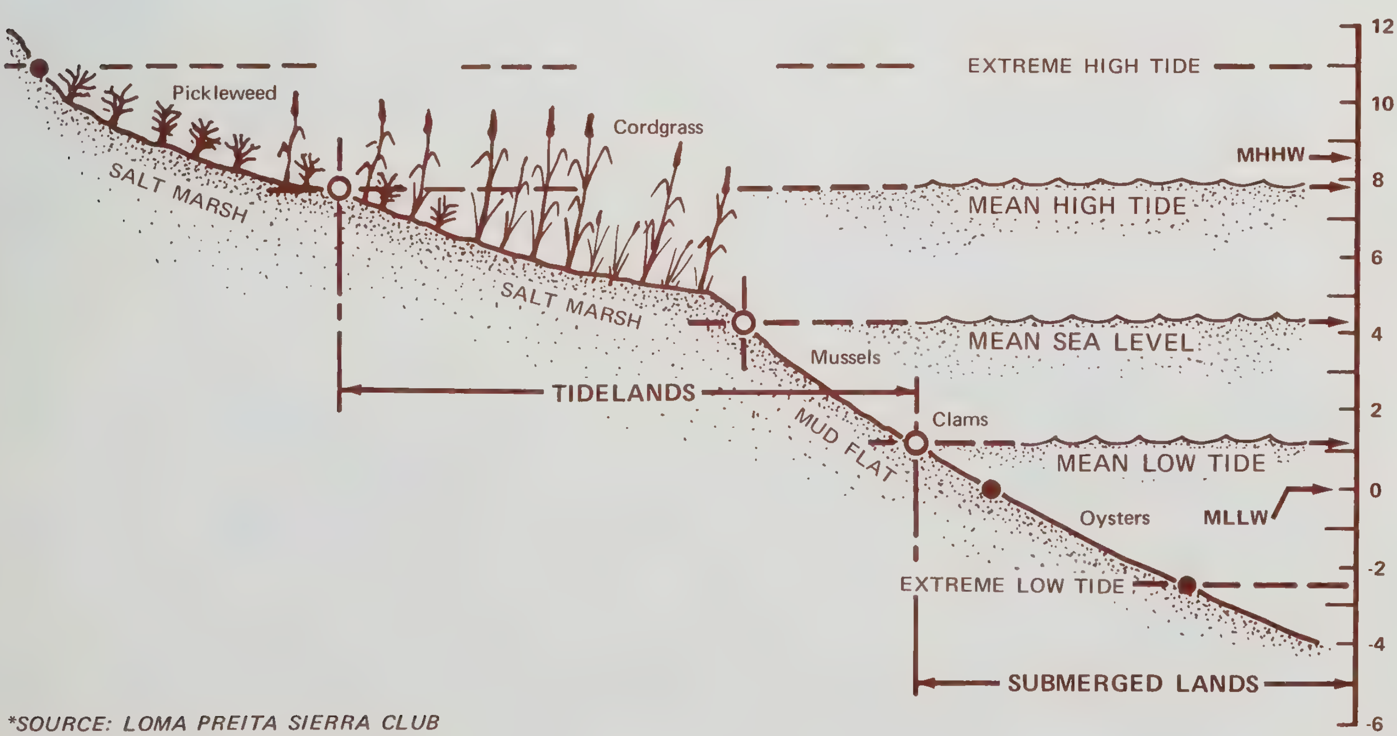
At one time the salt marsh habitat was one of the dominant elements of the Hayward shoreline, both in terms of the area it covered and in its ecological significance. Today, in the planning area less than four hundred acres remain — about five percent of the original total — that still deserve this designation. There are two major salt marsh areas, encompassing approximately 250 acres, located north and south of the mouth of the Alameda Creek Flood Control channel. A third diked marsh of moderate extent has been mapped northwest of Turk Island, along Plummber Slough, elsewhere, lesser strips and patches can be found along some of the creek channels and bordering parts of the bay.

Salt marshes generally occur at levels slightly higher than (and inland from) the tideflats but, like the mudflats, exist in a "not-quite-water, not-quite-land" situation. The environmental rigors of a salt marsh community include, among others, regular fluctuations of temperature and tide. To plants and animals alike, the salt marsh is a "chemical desert" with a scarcity of fresh water, a salty, alkaline soil, and an exposure to the drying effects of wind and evaporation — conditions which in many ways are as severe to life as those of a climatic desert.

Salt Marsh Vegetation

Most types of Bay Area vegetation, whether native or introduced, would find such environmental conditions prohibitively hostile. But in the salt marshes two major plant associations have evolved to utilize and flourish under these circumstances; together, they form the basis of a remarkably rich and productive habitat. In our area each of these associations is dominated by a single plant species: generally speaking, most salt marsh acreage consists of a solid, dense groundcover of Pickleweed (*Salicornia* sp.), with strips of Cordgrass (*Spartina foliosa*) occuping the shallow sloughs. Studies have shown that substratas usually have a lower shear strength and dry density under Cordgrass than under a Pickleweed marsh, and that soil erodibility and moisture content tend to be higher when associated with Cordgrass than with Pickleweed. Cordgrass is tremendously important in the economy of a salt marsh because of its extremely high productivity. Termed the "staff of life" for bay animals, it helps purify the air and produces five to ten times more nutrient material and oxygen per acre than well-known commercial crops such as wheat. Although it provides habitat and foraging niches for certain animals, Cordgrass become most ecologically valuable when it decomposes, thereby releasing nutrients that are washed into intertidal waters to feed invertebrates and fertilize algae beds.

Unlike Cordgrass, which can endure up to 21 hours of continuous submergence, Pickleweed — the most widespread salt marsh plant — is less water-tolerant and begins its best growth at the average high tide line. Its curious, succulent stems are characteristic of bayshore soils with salt contents as high as 6½ percent, and its root masses give stability to the banks of brackish channelways.



*SOURCE: LOMA PREITA SIERRA CLUB

Wildlife of the Salt Marshes

A variety of insects can be found in or around the salt marshlands, including moths, butterflies, beetles, ants, wasps, bumblebees, and the like. As its name implies the Salt Marsh Fly (*Ephydra* spp.) lives only around the marshes and salt ponds; likewise, the Salt Marsh Mosquito *(Aedes squamiger, A. dorsalis)* lays its eggs in quiet marshland ponds away from tidal currents.

Some salt marshes around San Francisco Bay play host to common shallow water fish such as anchovies, smelt, sculpin, and surfperch at high tide, with Threespine Stickleback *(Gasterosteus aculeatus)* sometimes remaining in nearby sloughs and potholes; however, it is not known if such species inhabit marshlands of the planning area. Similarly, Gopher Snakes *(Pituophis catenifer)* are reputed to invade upper salt marsh areas in the South Bay, but observations have not confirmed this along the Hayward shore.

In the planning area some 27 species of birds have been observed in salt marsh habitat, and at least eight others – perhaps more – may be found there from time to time as well. Over half of these are waterbirds, including a relatively high proportion of "wading" birds, probing shorebirds, and rails, while the rest are species usually associated with adjacent inland areas, such as hawks, insectivorous birds, and others. Two of these birds, the Clapper Rail *(Rallus longirostris)* and a subspecies of Song Sparrow *(Melospiza melodia pusillula)*, are critically dependent upon the salt marsh habitat for their survival. An estimated thirty to fifty Clapper Rails – officially listed by the U.S. Fish and Wildlife Service as an endangered species – live in the patches of salt marsh at the mouth of the Alameda Creek channel, where they nest amidst the Pickleweed. Cogswell (1973) believes the Black Rail *(Laterallus jamaicensis)*, rare to our area, may occur there as well.

The Song Sparrow subspecies, also a local resident, is restricted in its range to salt marshlands and adjacent dikes about San Francisco Bay from Richmond southward; probably their total population in the planning area is at least three to four hundred. In addition, the bulk of the planning area lies between the known ranges of a rare species of Salt Marsh Harvest Mice (*Reithrodontomys* spp.), the Red-bellied Harvest Mouse (*R. raviventris*), endemic to South Bay San Francisco, San Pablo and Suisun Bay salt marshes, and a close relative, the Western Harvest Mouse *(R. megalotis)*, which is widespread over most of western United States. Interestingly, the Red-bellied Harvest Mouse feeds on Pickleweed, drinks salt water, and excretes salt with its urine. By elimination of its habitat, this species is threatened with extinction. In our area, Harvey (1971) suggests that one of the two may possibly inhabit the salt marshes at the channel mouth of Alameda Creek.

Ecological Overview

Despite their spatial limitations, the strips and patches of salt marsh along the Hayward shoreline occupy a prominent place in the over-all environmental picture of the planning area. They support a wealth of interrelated – and sometimes specially adapted – organisms that range from inconspicuous algae growing on Pickleweed stems to graceful Marsh Hawks soaring overhead. They have served as part of a special "evolutionary laboratory" that today provides sanctuary for several rare and endangered species. And their luxuriant swaths of Cordgrass have helped earn the salt marshes their position as the most productive type of natural vegetation in North America.

For the ecological reasons outlined above, salt marshes should be given very high environmental priority in any plan for the use of bayshore lands.

SALT PONDS AND DIKES

Salt Production

Around South San Francisco Bay, much of what were formerly inland tidelands have been diked to create evaporating ponds for salt extraction. In the planning area, slightly over five thousand acres are presently in diked and ponded areas, and additional land, now dry, can be recognized as prior salt pond sites.

Salt ponds represent one of the most variable planning area habitats from the standpoint of the plant and animal life they are capable of supporting. Dissolved oxygen levels in the water increase and decrease significantly through time, creating a problem for pond life that is aggravated at night because aquatic plants consume, rather than release, oxygen in the dark, thereby further reducing the amount of this vital gas. In fact, decaying organisms can totally deplete the available oxygen at times, locally creating what is termed an "anoxic" situation. The availability of nutrients may likewise become a limiting factor for life and growth, as nutrient materials are rapidly assimilated by plants and animals in the low salinity ponds and remain "tied

WHITE PELICAN

CLAPPER RAIL
(RARE AND ENDANGERED)

LEAST TERN
(RARE AND ENDANGERED)

BLACK-NECKED STILT

SONG SPARROW
(RARE AND ENDANGERED)

BUFFLEHEAD

RED-BELLIED HARVEST MOUSE
(RARE AND ENDANGERED)

up" there until they are eventually released by bacterial action. All of these elements contribute to the rigors of the salt pond environment.

Even so, an interesting diversity of living forms inhabit at least some of the salt ponds. Probably the major food-producing organisms are a variety of algae and dinoflagellates. Rotifers, roundworms, and Mud Snails (*Nassarius* sp.) are among the invertebrate animals that flourish in some of the salt ponds, feeding on the algae and on each other. Other common to abundant organisms include Scuds or Fairy Shrimp (*Callianassa* sp.), Brine Shrimp *(Artemia salina)*, copepods, Water-boatman *(Trichocorixa reticulata)*, Brine Flies *(Ephydra cineria)*, seed shrimp, and polychaete worms.

Certain fish may also inhabit the salt ponds. Threespine Sticklebacks *(Gasterosteus aculeatus)* are sometimes prevalent in low-salinity waters, while Topsmelt *(Atherlinops affinis)* are capable of tolerating slightly high salt concentrations. Above six percent salinity the last remaining fish perish. The mudsucker, *(Gillichthys mirabilis)* survives in salty water and has been grown commercially as bait fish in some of the Leslie Salt Company ponds.

Waterfowl of the Salt Ponds

Of vertebrate animals that inhabit the salt pond areas, birds are by far the most conspicuous. In one study of five ponds during a two-year period (Anderson, 1970), over three hundred thousand birds were sighted in an area of about 2,500 acres. Comparable waterfowl abundance can be demonstrated in the Hayward shoreline planning area — ducks have been seen in concentrations of over ten thousand per square mile on local low-salinity ponds, while 17,000 Ruddy Ducks *(Oxyura jamaicensis)* have been sighted in one day on two salt ponds south of the old Alameda Creek channel.

Bird diversity also tends to be unusually high in the salt pond habitat. Of the 94 waterbirds that have been observed in the planning area, better than 65 — over seventy percent — have been sighted in salt pond areas; and interestingly, at least a dozen "land" birds can be found here at times as well. Most salt pond birds also spend a good deal of time locally in other types of habitat. A large number of "open bay" species visit the ponds, including grebes, geese, cormorants, phalaropes, Bonaparte's Gulls *(Larus philadelphia)*, and terns, while Scaup (*Aythya* sp.) and other ducks feed heavily on the ponds, especially in rough weather. Similarly, many mudflat birds — such as herons, egrets, plovers, probing shorebirds, American Avocets *(Recurvirostra americana)*, Black-necked Stilts *(Himantopus mexicanus)*, and gulls — can be found in salt pond areas, especially during periods of high tide. Black-bellied Plovers, and nearly all the species of Sandpipers (i.e., the bulk of the tideflat feeders) use the salt ponds during high tide periods primarily for roosting. A few birds even show strong preference for the salt pond habitat such as the White Pelican *(Pelecanus erythrorynchos)* and the Eared Grebe *(Podiceps caspicus)* and the Bufflehead *(Bucephala albeola)*, a diving duck, also occur most regularly on salt ponds, particularly those of middle-range salinities where Brine Shrimp abound. Also, all of the world's three existing phalarope species — the Red Phalarope *(Phalaropus fulicarius)*, Wilson's Phalarope *(Steganopus tricolor)*, and the Northern Phalarope *(Lobipes lobatus)* — occur on salt ponds of the Hayward area shoreline as migrants, two of them seeming to show marked preference for those ponds over other local habitats.

Recent studies of the relationship between salt ponds and wildlife have revealed some interesting facts about the food sources of salt pond waterfowl. Grebes, for instance, were found to ingest quantities of Brine Shrimp; shorebirds ate considerable numbers of Brine Fly larvae and puparia; Water-boatman appear to be a key food item of phalaropes; and polychaete worms were an important source of nourishment to Willets. Some birds exhibited dietary habits that may restrict them to certain of the ponds; as one example, certain ducks consumed rather high proportions of Widgeon Grass seeds, which in turn are produced only in ponds of relatively low salinity. In any event, waterbirds are not evenly distributed along the salt pond salinity sequence. Dabbling ducks, Coots, and fish-eating birds (such as terns, egrets, mergansers, and pelicans) prefer waters with the lowest salt content. On the other hand, diving ducks, grebes, phalaropes, and Bonaparte's Gulls demonstrate a high degree of salinity tolerance and a preference for food items existing in ponds of higher salinity. Shorebirds, however, will use for roost purposes ponds that are shallow enough for wading, irrespective of salinity.

Harvey (1973) has tentatively ranked salt ponds of the planning area according to relative wildlife value. Based on cursory observation he would, in general, rank the ponds between Coyote Hills Slough and Alameda Creek as highest in wildlife value. The western section of ponds between Alameda Creek and the San Mateo Bridge were ranked as of moderate value, and those of the eastern portion were thought to have a low value. Also, the ponds north of the approach to the San Mateo Bridge appeared to be of moderate value.

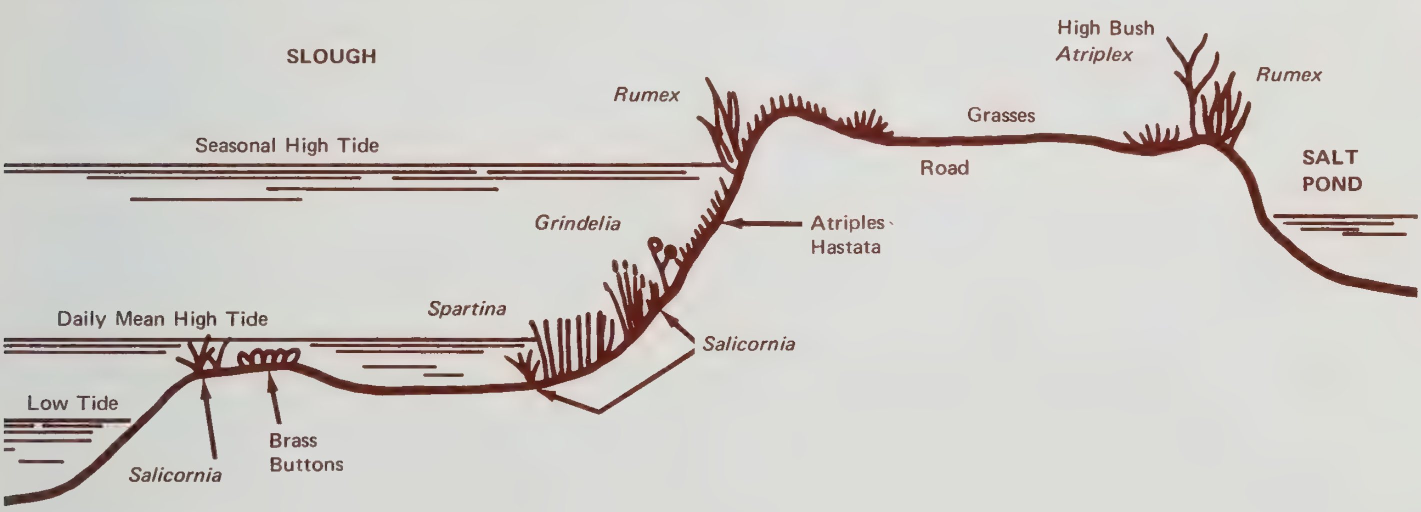
However, it was explained that a study over at least a year's time would be necessary to confirm these estimated evaluations of the ponds.

The Dike Environment

Of 28 plants that were found growing on the dikes of the salt ponds, 21 of them are alien (not native to the area). For the most part these are plants that colonize disturbed areas, and that are able to successfully compete for space against native species by virtue of their modifications for enduring drought, their high reproductive rates, and in most cases by an annual (single growing season) life style. That three-fourths of these plants are adapted to the man-made dike environment tells us, in effect, that their presence is more the result of human intervention in the area than of any inherent biological richness of this particular habitat. This situation contrasts clearly with that of the salt marsh, where the entire habitat is dominated by native plants such as Cordgrass and Pickleweed. Transition plants found between marsh and dike – such as Marsh Grindelia, Fat Hen, and Alkali Heath – are native to California as well. Unlike many of the aliens, these natives represent stable forms whose long-term presence in the region has allowed them to integrate into complex ecological associations; as an example, Marsh Grindelia is a valuable forage plant for many insects, such as bees and butterflies, and also for seed-eating birds. For such reasons, as well as for their historical significance, the native plants must be regarded as important and valuable members of the natural community.

In our area certain waterbirds – avocets, Black-necked Stilts, Forster's Terns, and Snowy Plovers – frequently nest on dikes; and from a regional standpoint, several Caspian Tern nesting colonies on salt pond dikes in San Francisco Bay are important ones in North America. Whether for nesting or for roosting, one main reason that dikes are useful for waterfowl is because of their isolation. Cogswell (1973) believes that such areas, protected from disturbance by humans, dogs, motor vehicles, and the like, are one of the most critical habitat features for probing shorebirds in a metropolitan area.

TYPICAL SLOUGH – SALT POND LEVEE CROSS SECTION*



* *SOURCE: ADAPTED FROM TUDOR – 1972*

Ecological Overviews

In the last analysis, the planning area's salt pond-dike system is something of a biological anomaly. The levees, power lines, and concentrations of brine underscore the highly altered nature of this environment, which has been described as "an intricate and fascinating system, a part of the largest solar evaporation plant complex in the world, and a colorful and important segment of the industrial community of the San Francisco Bay Region." As a setting for life, the value of this habitat can be exceedingly variable, ranging from barren, salt-encrusted margins of some of the ponds to spectacular displays of pelicans, egrets, and herons that can be found in season – at the right places. The areas on and around the dikes are home to a curious sequence of highly-adapted plants that live under conditions which are prohibitive to the vast majority of members of the plant kingdom.

Besides serving as a wildlife habitat, salt pond areas have several other values that extend beyond the limitations of salt production. They support compatible commercial enterprises like brine shrimp production and marketing of bait fish. Waterfowling leases are an additional area of economic and recreational interest; in our area, duck hunters visit Leslie Salt Company ponds as well as the gun club ponds to the east of them.

MINOR MISCELLANEOUS HABITATS

Limited acreages of two other habitat types occur in the planning area: diked dry areas and freshwater ponds. Because they play relatively minor roles in the overall ecological picture, they will be treated briefly here.

Dry Diked Areas and Dumps

About 1,700 acres of planning area terrain are presently diked off and relatively dry. Since some of this area is composed of previous salt ponds, relatively high salinity can be a limiting environmental factor. For this reason and because of their aridity, Harvey (1973) considers these areas to be particularly low in ecological value since they lack much life; but he notes that, like low-value salt ponds, they serve as open-space areas that do not contribute greatly to air pollution and do not restrict air movement – thus are ecologically more valuable in their present state than they would be if urbanized.

Of some interest is the dump at the end of West Winton Avenue, which belongs to this general habitat type. As a rule, sanitary fills tend to smell bad and are unsightly; in addition, rainfall-leaching (and flood-leaching) in dump areas can result in seepage of polluted water and contamination of the environment. Despite these detrimental impacts, however, considerable wildlife may be attracted to disposal sites. While sanitary fills are never balanced ecosystems – vegetation cannot find a foothold in an active site – the fill does contribute a supporting food niche to adjacent habitats. In particular, hordes of gulls are commonplace – up to 13,000 of these birds have been reported in winter at the Winton Avenue site.

Seasonal Freshwater Ponds and Related Habitats

Limited amounts of shallow freshwater habitat are present in the planning area, the exact acreage varying with the time of year. This important, non-saline aquatic element is provided primarily by gun club ponds, the oxidation ponds of the sewage treatment plant, and winter floodplain accumulations. Freshwater habitats in general – ponds, marshes, or others – often contain a variety of green plants which in turn support a diverse pyramid of life, from aquatic micro-organisms to larger, more conspicuous forms.

"Upland" Areas

In addition to its other major habitats, the Hayward shoreline planning area contains over two thousand acres of land which have been collectively termed "upland" terrain. These uplands occupy an irregular strip along the northeastern boundary of the planning area behind the mudflats, salt marshes and salt ponds; essentially they are part of the extensive "bay plain" region upon which San Lorenzo, Hayward, and Alvarado have been built. They include land now in residential or industrial use (not discussed here) and also grassy or weedy land which now lies fallow. Much of the area is underlain by a substratum which is too high – in some cases only by a matter of a few feet – for tide flooding. While parts of it may be flooded by winter rains, the land is comparatively dry. Salt or brackish water often lies only a short distance below ground level, so that deep-rooted plants do not grow well. Prolonged exposure to sun and wind are other limiting physical elements of the fallow upland habitat. In terms of component vegetation the open upland areas closely resemble the dikes, except that many of the native salt-tolerant species may be absent. As on the dikes, several important non-native grass species are joined by a diverse group of other non-native herbaceous plants, resulting in a 'weedy' groundcover that extends beyond the fields and pastures to re-invade the fringes of adjacent developed areas.

Fields and other undeveloped upland areas are capable of providing habitat for an interesting variety of animals. A wide variety of insects are found here. Reptiles include the Western Fence Lizard *(Sceloporus occidentalis)* and the Gopher Snake *(Pituophis catenifer)*. A large proportion of the planning area's 'land bird' species are associated with relatively undeveloped upland habitats, and a number of water birds sometimes find their way into the area as well. Common mammals to be expected include, among other, Black-tailed Jack Rabbits *(Lepus californicus)*, Gophers *(Thomomys bottae)*, California Ground Squirrels *(Citellus beecheyi)*, and California Meadow Mice *(Microtus californicus)*. In the uplands, as elsewhere, an interlocking web of life binds many of these forms together.

Isolated Hills

Near the southern boundary of the planning area a pair of small hills rise conspicuously above the bay plain. Physiographically these are a northern extension of the Coyote Hills, and the most prominent of the two, known as Turk Island, attains a maximum elevation of only 116 feet above sea level. Even so, this difference in height, slope, and substrata – and perhaps in human land use – is sufficient to produce a marked change in the vegetation of these areas and to permit many wildflowers and other plants to flourish on these low hills that may be absent or uncommon elsewhere in the planning area.

For the most part, the plants of these hills are quite typical of grasslands throughout the coast ranges of central California and are therefore not actually rare or endangered species. But in the larger sense, the isolated nature of the hills places them in an ecological situation which – in its undeveloped state – is quite uncommon along the shore of San Francisco Bay. Well over forty different kinds of plants are found on or at the foot of the hills. In a vegetational sense, then, the hills should be ranked among the richest and most diverse of habitats to be found in the planning area.

Planning Implications

In the Hayward Shoreline area are major habitats that are more valuable than others. The salt marsh is most valuable, followed by open water, mudflats, and some salt ponds. Upland areas and dry diked areas rank lowest.

From every ecological standpoint, the small patches of salt marsh at the end of the Alameda Flood Control channel should remain inviolate. Because of the dependence of several rare species on this specific habitat (including the Clapper Rail, a subspecies of Song Sparrow, and possibly the Salt Marsh Harvest Mouse) and because of the extremely high productivity of its biological system, the existing salt marsh areas should definitely be retained.

Other suitable shoreline areas (such as some low-salinity salt ponds) should be encouraged to revert to this habitat form.

Other areas exposed to tidal action – the mudflats and open waters – should be exempted from further development. They are necessary for the support of large, attractive migratory waterfowl populations, and they are instrumental in the circulation of nutrients upon which the bay's fishery depends.

Diking of the bay greatly diminished wildlife values in many areas and continued filling would be unwise. Sanitary filling destroys habitats of biological worth.

If salt production is curtailed, low-salinity ponds may be re-exposed to tidal action through dike breaching and in a relatively short time should revert to high-quality salt marsh.

Some low to moderate salinity salt ponds should be retained since a wide variety of water birds use them.

Salt pond dikes possess a biological value primarily as root sites and should not be disturbed.

Freshwater habitat is nearly absent in the planning area. Any increase in the acreage of freshwater ponds would be desirable and highly beneficial to wildlife.

The residential and industrial areas of the "uplands" have low ecological values, however the isolated hills in the southern portion, in particular, contain biological features (an uncommon plant assemblage) that merit their preservation.

The wildlife habitat should be preserved as there is little likelihood that the waterfowl using the existing habitat will go elsewhere. A reduction in habitat almost always demands a further reduction in animal numbers.

The planning area could continue to support limited salt production as well as other compatible enterprises such as brine shrimp harvesting, bait fish marketing, and perhaps waterfowl hunting leases.

Shoreline access must be supervised, limited, and directed to avoid disturbing some areas of waterfowl concentration.

Land Use Synthesis

A land use synthesis is proposed for the Hayward Shoreline Area, based upon the various environmental factors considered in the first section of this report, the Environmental Analysis.

Portions of the study area are thus classified into areas capable of development; areas to remain as open space or developable for recreation; and areas reserved for ecological purposes (areas to remain in or to be restored to a natural state). The proposed land use classification is shown on Plate 5.

Developable Areas

The upland area of the Hayward Shoreline Area, which is bordered on the east by the Southern Pacific railroad and extends toward the bay to the seven-foot elevation contour, is considered to be capable of intensive development.

The soils and geologic conditions are such that no unusual engineering foundation problems are anticipated. The usual problems of construction are those associated with building on low-lying lands with a high water table and highly expansive soils.

This area is not subject to flooding and has no high ecological value.

Potentially Developable Area

The land area between the seven-foot elevation contour and the contour delineating the thickness of the underlying bay mud as five feet is considered to be developable with proper engineering controls and adequate inspection. Various techniques of good foundation engineering practice are available to obviate the foundation problems of differential settlement on this type of ground. Proper design for structures in this area may include either the use of a pile foundation, or excavation and removal of the soft by mud.

Part of this area would be susceptible to flooding, should the outboard dikes be breached and the salt ponds restored to tidal action. In this event, adequate dike protection would be required and provisions made for draining surface waters from heavy rains.

There would be little or no conflict with the ecological environment in the event this area was to be developed.

Areas to Remain as Open Space or Developable for Recreation (Recreation, cattle grazing, natural areas, salt production)

The remainder of the study area, except for those areas designated as remaining in a natural state or to be restored to a natural state, is classified as suitable for use as open space (recreation, salt production, or natural). This area lies west of the five-foot mud thickness contour and encompasses the present salt ponds and dry, diked areas.

The area is considered to be unsuitable for development because of the engineering problems associated with building structures on the unstable bay muds, including the stability of fills; and the potential seismic effects on any fill or attendant developments on it and the existing levee system that would lead to earthquake damage and/or flooding. The earthquake or flood damage would lead to financial losses that would be translated in part to the taxpayers of Alameda County. However, the area is suitable for open space uses such as recreation, sanitary land fill, and salt production. Although geologic conditions are detrimental to intensive development, the soils conditions (imperviousness of the silty clay soils principally) are favorable to sanitary land fill operations, which in turn can be converted to parks or golf courses.

The contribution of the salt ponds to flood control and as a climatic factor lends support to the continuance of a salt production industry and retention of the salt ponds as open space. In addition, some low-to-moderate salinity salt ponds are valuable because of the wide variety of water birds that use them. Indeed some species are dependent upon their presence.

The location of the study area to the San Francisco Bay enhances the value of this area for water-oriented recreational uses. The creation of fresh water lakes in this regard would help the wildlife.

Areas Reserved for Ecological Purposes

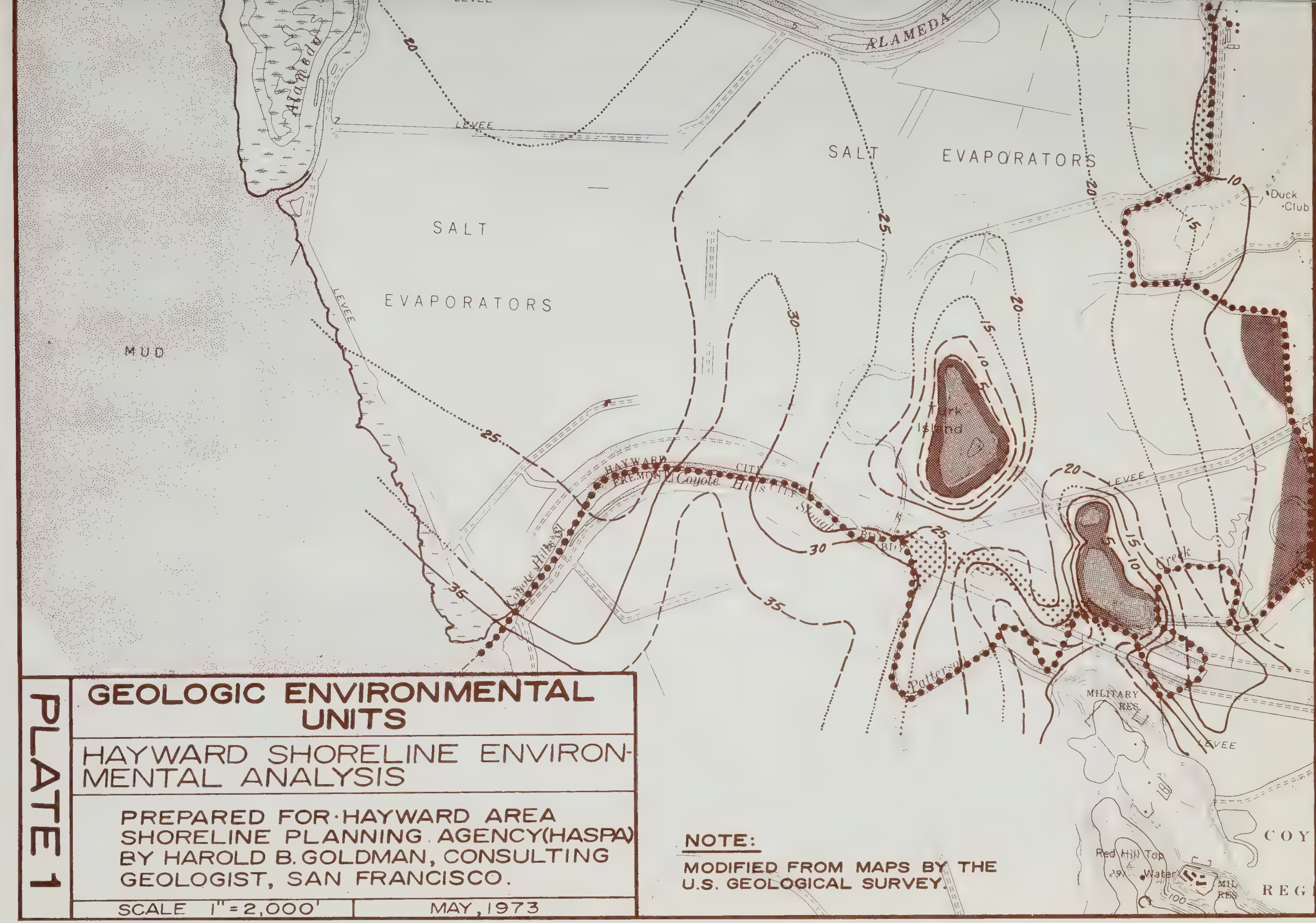
Specific portions of the study area are recommended to be retained in a natural state. These are salt marshes that have a high ecological value because of the high productivity of its biological systems and the dependence of several rare species on the specific habitat.

Other shoreline areas, such as some low-salinity salt ponds, are recommended to be restored to this habitat type. The low-salinity intake ponds may be exposed to tidal action through dike-breaching and in a relatively short time should revert to a high quality salt marsh. One specific area adjacent to the Alameda Creek flood control channel is designated on Plate 5. The criteria for restoring this area are: it has suitable substrata for marsh restoration, e.g., not heavily salt encrusted; it is suitably located to the bay for adequate tidal exchange; it is large enough to be useful as a center of primary plant production and to serve as habitats for endangered wildlife; it is at the same historic elevation; and it would not eliminate salt ponds of high wildlife value.

Salt pond dikes likewise have a unique biological value and cannot accommodate human intervention; otherwise, loss of breeding colonies and abandonment of roosts will result. Endangered populations can be preserved by maintaining at least three such shorebird roosts.

Included in this classification are some dry-diked areas that because of their potentially high ecological value as a former salt marsh may be restored to a natural condition.

FINIS



GEOLOGIC ENVIRONMENTAL UNITS

PLATE 1

HAYWARD SHORELINE ENVIRONMENTAL ANALYSIS

PREPARED FOR·HAYWARD AREA SHORELINE PLANNING AGENCY(HASPA) BY HAROLD B. GOLDMAN, CONSULTING GEOLOGIST, SAN FRANCISCO.

SCALE 1" = 2,000'	MAY, 1973

NOTE:

MODIFIED FROM MAPS BY THE U.S. GEOLOGICAL SURVEY.

Hayward Shoreline Planning Program

THE AGENCY

The Hayward Area Shoreline Planning Agency (HASPA) was formed in January 1971 by a joint exercise of powers agreement among East Bay Regional Park District, Alameda County, Hayward Area Recreation and Park District, and the City of Hayward.

The Agency's initial function was to prepare a statement of mutually agreeable land use policies for the Hayward Shoreline.

To assist HASPA, a Technical Advisory Committee and a Citizens Advisory Committee were formed. The Technical Advisory Committee, which was made up of staff representatives from each of the member agencies plus the Bay Conservation and Development Commission, prepared background reports that covered various aspects of the Shoreline environment, the economic conditions that affect future land uses, and the demand for recreation facilities. The Citizens Advisory Committee, which was appointed in 1973, included five persons from each member agency. This Committee recommended those policies and implementation measures needed to reflect the public interests in the Shoreline.

In January 1974 HASPA completed a statement of proposed Shoreline policies. Since that time all of its member agencies have adopted consistent statements—as part of their General Plans.

Having reached this accord, HASPA is now coordinating the implementation of this plan.

THE STUDY AREA

The Hayward Shoreline includes eight miles of San Francisco Bay frontage between the City of San Leandro on the north and the San Francisco Bay National Wildlife Refuge (City of Fremont) on the south.

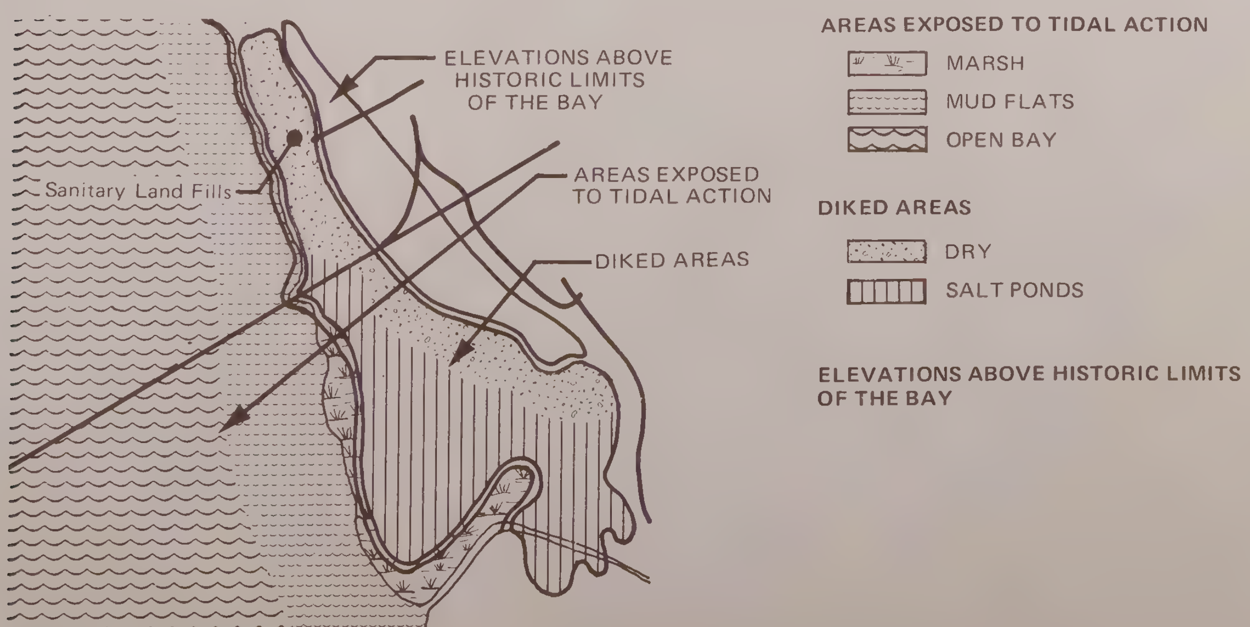
Variations in the elevation of adjacent areas are slight and the slope of the land very gradual.

Above the historic tidal zone is an area which is presently being developed for industry. Bayward of this development, and within the historic marsh zone, an area of some 8000 acres has been diked off from tidal action. This area has historically been used by the salt production industry for salt water evaporation ponds. About 70% of this area is still used for this purpose. The remaining 30% of this area is now used as grazing land, "sanitary" land fills, or is simply held by its present owners for investment purposes. Approximately 130 miles of flood control channels traverse this area and carry the rain runoff from the urban areas to the east to the Bay on the west.

Westerly of the diked areas is salt marsh, mud flats, and open Bay. During high tides the Bay waters extend up to the privately constructed and maintained diking system. At very low tides the adjacent mud flats will extend out from the dikes for more than one mile.

The highly conspicuous waterfowl population is one of the most dominant features of the Shoreline. Annually the hundreds of thousands of birds that migrate along the Pacific Flyway use San Francisco Bay and the Hayward Shoreline as vitally important feeding and resting areas. Some fly through the area in spring and fall, while others stay to winter in the shelter of the Bay. When these migratory birds are added to the resident waterfowl population, the number of birds found locally attains remarkable proportions.

Private interests exert control over all of this Shoreline area although the legal title to many of these properties is being questioned. These interests restrict public access to the Bay, and in many instances preclude the use of the Shoreline for its outstanding ecological and recreational purposes.



FINDINGS

Areas Above the Historic Tide Zone

In the areas which were not historically subject to tidal action, geological and soil conditions do not impose significant engineering problems for development. Nor is most of this area considered to be an important wildlife habitat. The industrial development that is occurring here now improves the East Bay's economic base and provides important local employment opportunities. This development is therefore considered desirable and appropriate.

Diked Areas

Within the diked-off area, soil conditions change. Here, deposits of highly compressible silty clays, termed "young muds," affect development potential of these properties. Where the deposits of young mud are shallow, stable building sites can be prepared—but at a considerably higher cost than for such facilities in areas not affected by these conditions. Where deposits of young mud are deep, construction costs for structures and utilities are even higher and earthquake-related hazards become significant. Earthquake-induced ground shakings in these loose, water-saturated sediments are more intense, last longer, and generally cause far greater damage to structures and utilities located in these soils than to comparable developments located elsewhere.

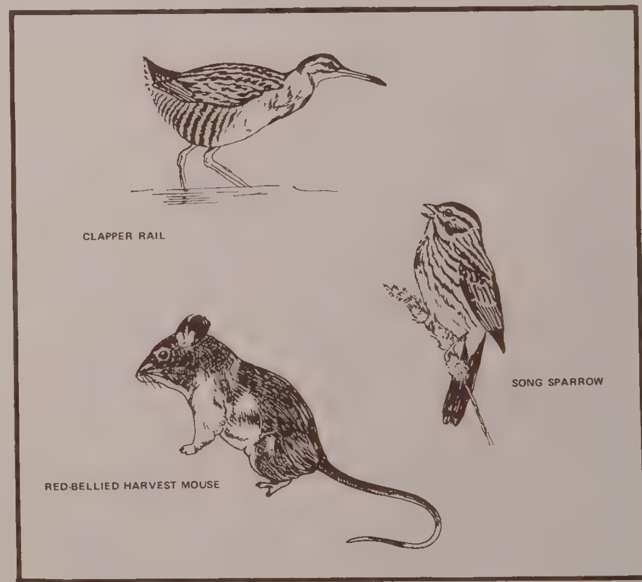
Ecologically, these diked areas are highly productive or potentially productive. The salt water evaporation ponds located in this area provide habitat for pelicans, egrets, herons, terns, phalaropes, and many other species. The abundance of wildlife varies from pond to pond but it is not uncommon to sight several hundred thousand birds in several hundred acres of pond. The salt production industry is also important to the local economy, and the extensive water surface of the evaporating ponds acts to moderate climatic conditions in adjacent areas by keeping temperatures more constant.

In their present state, dry-diked areas are less important as wildlife habitats than the ponds; however, their potential significance is substantial. Located in the historic tidal zone, reversion of these areas to their former state as salt marsh would add to this important habitat, which is commonly described as being the most productive environment in North America.

Marsh, Mud Flats and Open Bay

Outboard of the diked areas, geological conditions and construction costs preclude all non-essential public development. The salt marsh, mud flats and open Bay waters located here are highly significant ecologically.

The highly productive salt marshes produce nutrients that feed the invertebrates that form the beginnings of the Bay food chain. The marsh also provides habitats for a number of rare and endangered species. Included in this list are the Red-bellied Harvest Mouse, the Clapper Rail, and a subspecies of the Song Sparrow (Melospiza melodia pusillula). In all, there are some 27 species of birds that spend their lives in the salt marsh and at least eight other species that use the marsh at various times in their life cycle.



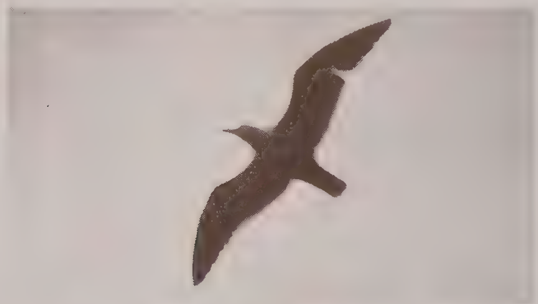
In the shallow Bay water and tidal mud flats, a wide variety of minute marine organisms provide foodstuff for all of the larger birds, fish and mammals that live along the Bay. A total of about 125 species of fish and 72 species of birds are found in the Bay and on the tide flats.

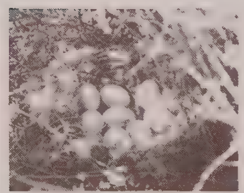
THE SHORELINE PLAN AND ITS IMPLEMENTATION

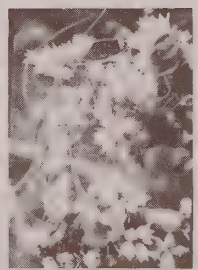
Development

Industrial development is proposed by the plan in those areas that are not environmentally sensitive, where private development costs will be reasonable and where public maintenance costs will be justifiable.

To overcome traffic congestion presently produced by the industrial Areas, HASPA has endorsed studies, now underway under a separate joint powers agreement, to determine if there is a need for an additional transportation corridor. If constructed, this facility would be designed to reduce traffic congestion in the urban part of the Shoreline as well as to provide access to the open space and recreation facilities proposed along the Bay. Membership in the joint powers agency studying the need for this facility includes the State Department of Transportation, the Metropolitan Transportation Commission, the County of Alameda, the City of Hayward, and the City of San Leandro.







Photos by Philip Gordon

Recommendations in the Dry-Diked Areas

HASPA's policies propose public acquisition of those dry-diked areas where the removal of the protective dikes will result in the restoration of the former marsh habitat. Where the disposal of solid waste materials has occurred, these properties can no longer be restored—the elevations of these sites are now above the high tide line of the Bay. Where properties have been thus filled, active, Bay front recreation is proposed.

Both East Bay Regional Park District and the Hayward Area Recreation and Park District (HARD) have indicated their interest in purchasing portions of these properties, and HARD and the City of Hayward have already assigned their share of the Z'berg/Collier (Proposition #1) bond funds for this purpose.

Assistance from State and Federal agencies and the use of State and Federal revenues is also appropriate here. The restoration of wildlife habitats and the development of regional recreational facilities will benefit the entire Bay Area and complement other State and Federal shoreline projects already underway.

Since the restoration of diked areas as marsh is a highly effective way of improving the ecological productivity of San Francisco Bay, HASPA is also proposing the restoration of these marsh areas as appropriate to overcome the adverse environmental impacts that may be associated with otherwise desirable public and private projects. The Bay Conservation and Development Commission has required this type of action as a condition for approval of the proposed new Dumbarton Bridge, and HASPA is very much interested in seeing the Toll Bridge Administration purchase up to 200 acres of the dry-diked area in the Hayward Shoreline and the conversion of these lands to marsh. As other public and private activities occur, similar conversions may be required which will improve San Francisco Bay and restore more shoreline to this important wildlife habitat.

Since many of Hayward's diked properties may still belong to the State, ~~help from the State~~, help from the State Lands Division is also needed to protect the public's rightful ownership of these sites and prevent the expenditure of public funds for lands already owned by the State.


Photo by Herbert Brodahl

Salt Ponds, Marshes and Mud Flats

Preservation of these areas is proposed to be accomplished through the use of land use regulations. The Corps of Engineers and BCDC have jurisdiction over these areas and the County of Alameda and the City of Hayward are responsible for maintaining zoning over the unincorporated and incorporated portions of the Shoreline, respectively. To maintain property taxes at commensurate levels with the income derived from these sites, both the County and City will establish agricultural preserves on these properties.

The eventual addition of these portions of the Hayward Shoreline to the San Francisco Bay National Wildlife Refuge is also very desirable. Hayward's salt ponds, marshes and mud flats are important wildlife habitats, comparable to those already planned to be included in the abutting National Refuge.

Shoreline Recreation Facilities

Recreation facilities are proposed by East Bay Regional Park District and the Hayward Area Recreation and Park District on the areas presently used for sanitary land fill. They will include picnic areas, play fields, and fishing facilities. In addition to this, the HASPA Plan proposes the construction of a bicycle and hiking trail which would extend through the entire Shoreline and be maintained by East Bay Regional Park District. A wildlife interpretive center, also proposed to be constructed in a reconstituted marsh, will be developed and maintained by the Hayward Area Recreation and Park District. Finally, if the extension of an access channel is found to be environmentally and economically feasible, a marina will be constructed by the City of Hayward.

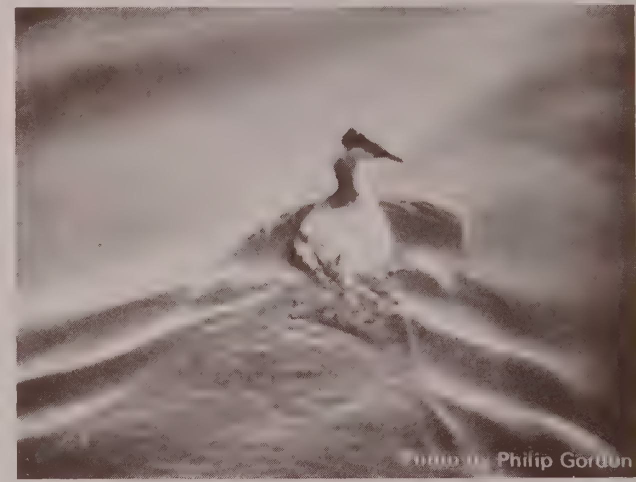


Photo by Philip Gordon

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PARTICIPATION

The shoreline plan was prepared in concert with a wide diversity of interest groups. It is endorsed by property owners, environmentalists, developers and park and recreation interests and has the support of the community's many public service organizations.

Membership in HASPA and its advisory committees is as follows: ***HAYWARD AREA SHORELINE PLANNING AGENCY: East Bay Regional Park District,*** *Dr. Howard Cogswell, Mr. William Jardin, Alternate;* ***Alameda County,*** *Mr. Joseph Bort, Mr. Fred Cooper, Alternate;* ***Hayward Area Recreation District,*** *Mrs. Shirley Campbell, Mr. Douglas Morrisson, Alternate;* ***City of Hayward,*** *Mrs. Ilene Weinreb, Chairman; Mr. George P. Oakes, Alternate.* ***HAYWARD AREA SHORELINE PLANNING TECHNICAL ADVISORY COMMITTEE: East Bay Regional Park District,*** *Mr. Lew Crutcher;* ***Alameda County,*** *Miss Betty Croly, Mrs. Jesse Cambra, Mr. Jim Wilson;* ***Hayward Area Recreation District,*** *Mr. Wes Sakamoto;* ***City of Hayward,*** *Mr. Bruce Allred, Project Coordinator; Mr. Martin Storm, Chairman;* ***Bay Conservation & Development Commission,*** *Mr. Jeff Blanchfield.* ***HAYWARD AREA SHORELINE PLANNING CITIZENS ADVISORY COMMITTEE: East Bay Regional Park District,*** *Dr. Arthur B. Emmes, Chairman; Mrs. Meda Soares, Mrs. Janice Delfino, Mr. Philip Gordon, Mr. William J. Bland;* ***Alameda County,*** *Ms. Helen Freeman, Mr. Wes Gauveia, Mr. Edward Blanchard, Mr. Thomas Southworth; Ms. Betty Williams;* ***Hayward Area Recreation District,*** *Mrs. Lillian Gallo, Vice Chairman; Mr. Herbert Brodahl, Mr. George Enderlin, Mr. Don LaPlante, Mr. H. M. Volheim, Dr. Fred Buerstatte, Alternate; Mr. F. Eugene Ward, Alternate;* ***City of Hayward,*** *Mr. Bruce G. Close, Mr. Leo F. Bachle, Mr. William Taylor, Mr. Roy Manning, Mrs. Marie B. Lee.*

Prepared by Hayward Planning Department July 1974

HAYWARD SHORELINE

SUMMARY OF CONSERVATION AND DEVELOPMENT POLICIES
HAYWARD AREA SHORELINE PLANNING AGENCY (H.A.S.P.A.)
JANUARY 16, 1974

PLATE 5

GENERAL LAND USE CAPACITIES

HAYWARD SHORELINE ENVIRONMENTAL ANALYSIS

PREPARED FOR HAYWARD AREA SHORELINE PLANNING AGENCY (HASPA) BY HAROLD B. GOLDMAN, CONSULTING GEOLOGIST, SAN FRANCISCO.

SCALE 1" = 2,000' | MAY, 1973


LEGEND
OLD ALLUVIAL SEDIMENTS
AREA UNDERLAIN BY YOUNG "BAY MUD" LESS THAN 5' IN THICKNESS
AREA UNDERLAIN BY YOUNG "BAY MUD" MORE THAN 5' IN THICKNESS
AREAS SUBJECT TO LIQUEFACTION OR LATERAL SPREADING
STUDY BOUNDARY
THICKNESS CONTOUR-YOUNG BAY MUD
UNCERTAIN
INFERRED
SAN LORENZO
Russell City
HAYWARD MUNICIPAL AIRPORT
Mt Eden Sta
Johnson Landing
SALT EVAPORATORS
MUD
FLOOD CONTROL CHANNEL
ALAMEDA
Baumberg
Chabot College
UNION CITY
PLATE 1
GEOLOGIC ENVIRONMENTAL UNITS
HAYWARD SHORELINE ENVIRONMENTAL ANALYSIS
PREPARED FOR HAYWARD AREA SHORELINE PLANNING AGENCY(HASPA) BY HAROLD B. GOLDMAN, CONSULTING GEOLOGIST, SAN FRANCISCO.
SCALE 1"=2,000'
MAY, 1973
NOTE:
MODIFIED FROM MAPS BY THE U.S. GEOLOGICAL SURVEY.

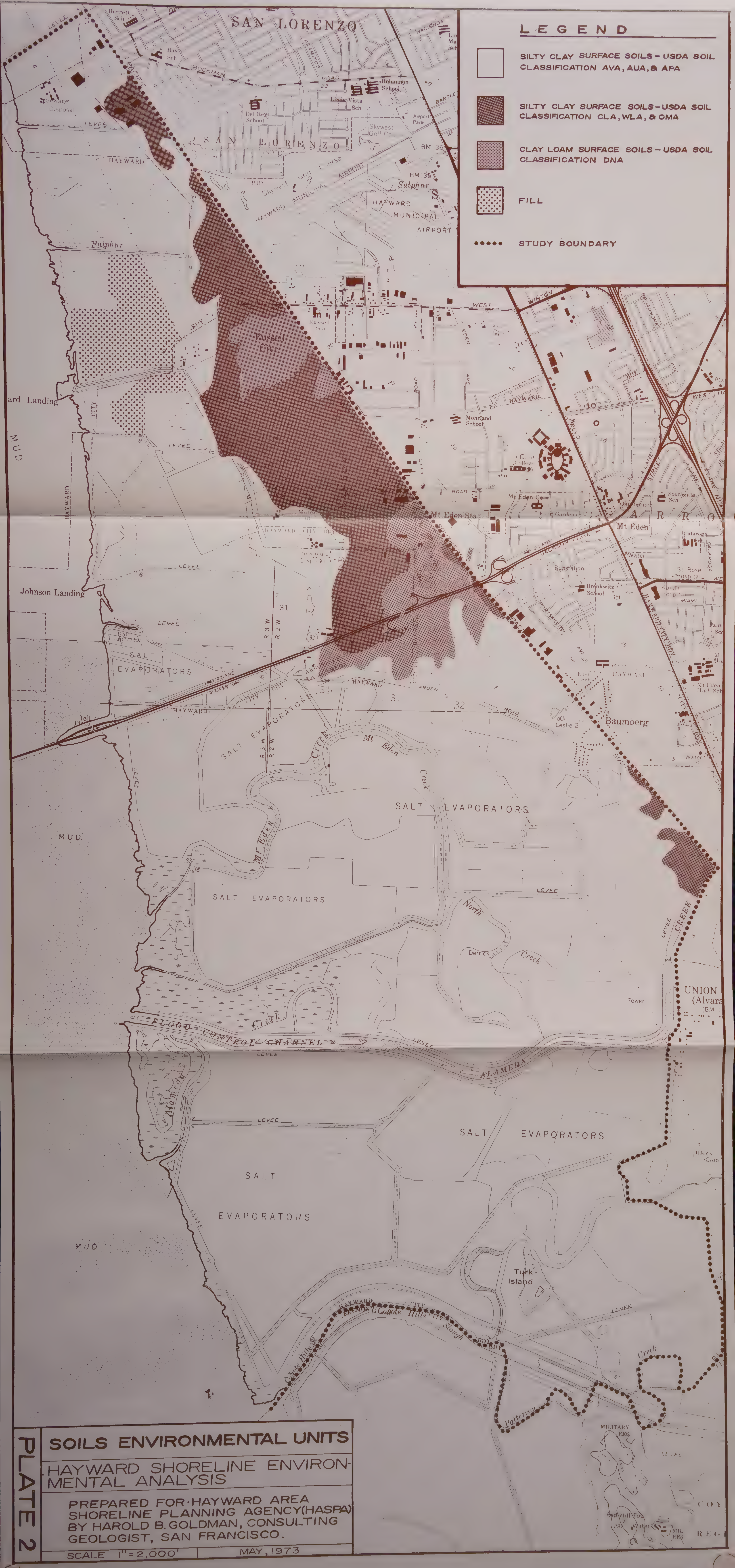

PLATE 2

SOILS ENVIRONMENTAL UNITS

HAYWARD SHORELINE ENVIRONMENTAL ANALYSIS

PREPARED FOR HAYWARD AREA SHORELINE PLANNING AGENCY (HASPA) BY HAROLD B. GOLDMAN, CONSULTING GEOLOGIST, SAN FRANCISCO.

SCALE 1" = 2,000' MAY, 1973

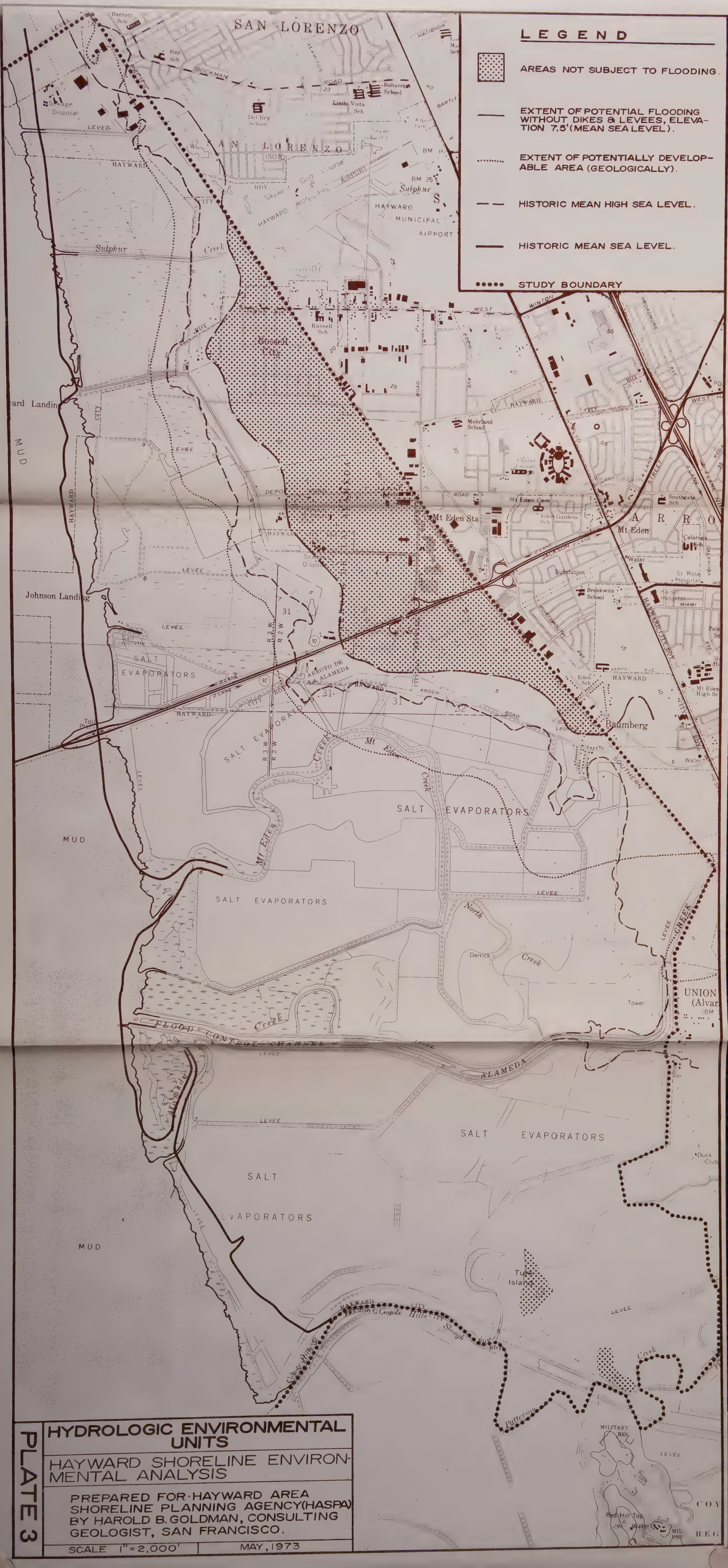

PLATE 3

HYDROLOGIC ENVIRONMENTAL UNITS

HAYWARD SHORELINE ENVIRONMENTAL ANALYSIS

PREPARED FOR HAYWARD AREA SHORELINE PLANNING AGENCY(HASPA) BY HAROLD B. GOLDMAN, CONSULTING GEOLOGIST, SAN FRANCISCO.

SCALE 1"=2,000' | MAY, 1973

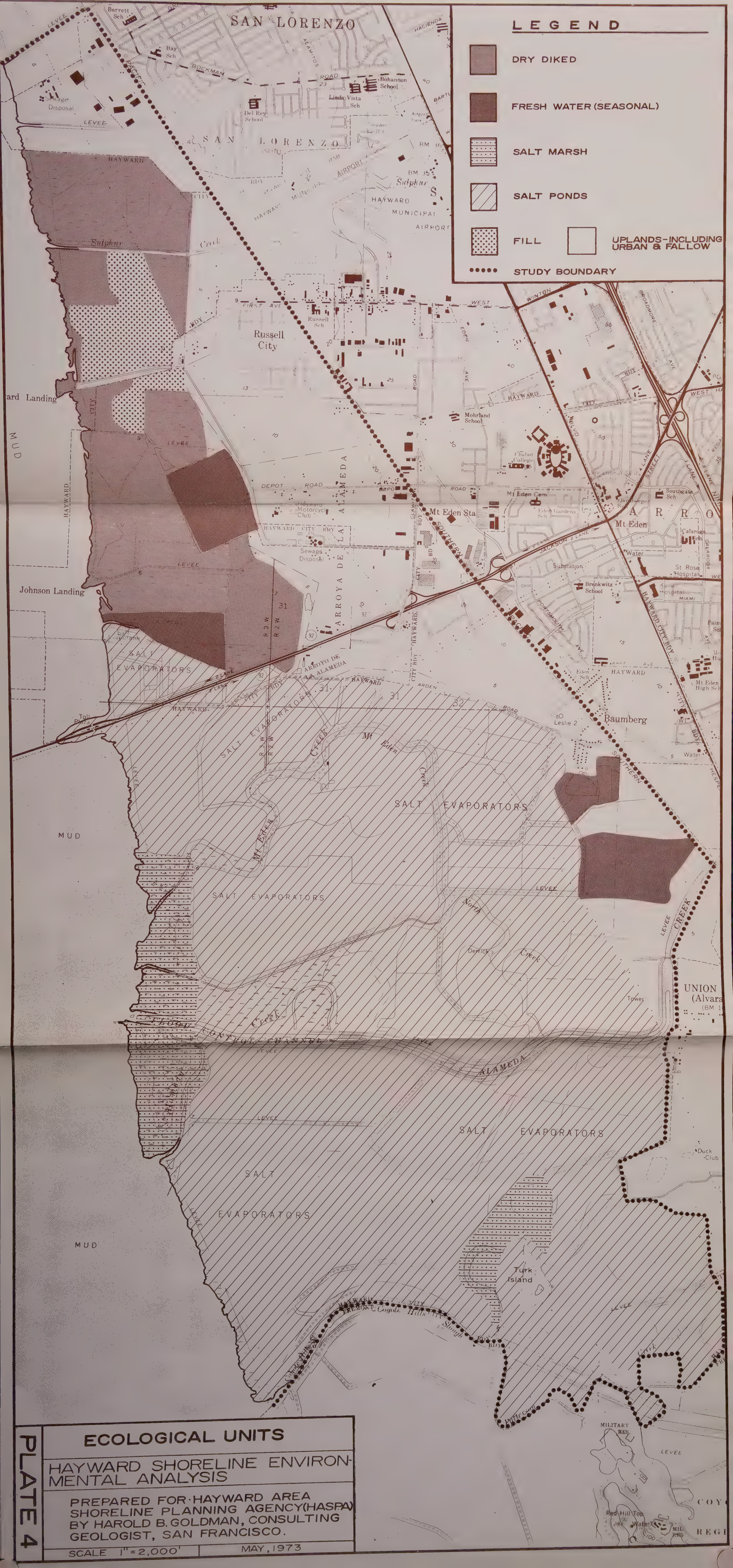
LEGEND
DRY DIKED
FRESH WATER (SEASONAL)
SALT MARSH
SALT PONDS
FILL
UPLANDS-INCLUDING URBAN & FALLOW
STUDY BOUNDARY
SAN LORENZO
Russell City
Johnson Landing
Mt Eden
Baumberg
SALT EVAPORATORS
MUD
Turk Island
UNION
PLATE 4
ECOLOGICAL UNITS
HAYWARD SHORELINE ENVIRONMENTAL ANALYSIS
PREPARED FOR HAYWARD AREA SHORELINE PLANNING AGENCY (HASPA) BY HAROLD B. GOLDMAN, CONSULTING GEOLOGIST, SAN FRANCISCO.
SCALE 1"=2,000'
MAY, 1973

PLATE 5

GENERAL LAND USE CAPACITIES

HAYWARD SHORELINE ENVIRONMENTAL ANALYSIS

PREPARED FOR HAYWARD AREA SHORELINE PLANNING AGENCY(HASPA) BY HAROLD B. GOLDMAN, CONSULTING GEOLOGIST, SAN FRANCISCO.

SCALE 1"=2,000' | MAY, 1973

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PHOTOGRAPHS

Richard Persoff—vi • Hayward Chamber of Commerce—4
San Francisco Bay Conservation and Development Commission—6
Michael Bry—17 • Herbert Brodahl—24, 34

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